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AVIATION

IN THIS ISSUE

10th Annual Maintenance Issue

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VIATION and AIR ANSPORT present in- stry's top honors to e service and over- ul employees for tstanding perform- ce and development citations on page 36. ecial feature section llows, plus greatly panded Mainte- nce Notebook.

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SIMPLIFIED DESIGN PAYS OFF TWICE

w Eda engineers redesigned rts for production and intenance ease. Result: ver costs and lighter weight.

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A NEW APPROACH TO COST ANALYSIS

e of power-space-density nominators gets precise air- ft operating figures.

McGRAW-HILL
UBLISHING COMPANY, INC.

AVIATION

CONTENTS FOR DECEMBER, 1946

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10th Annual Maintenance Issue

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The following publication is combined with AVIATION: AERONAUTICAL ENGINEERING, AIRCRAFT JOURNAL. All rights to this name are reserved by the McGraw-Hill Publishing Co. Aviation is indexed in Readers' Guide to Periodical Literature and in Industrial Arts Index.

Like a Bolt From the Blue, it seems, was the sudden realization that the lightplane market has abruptly gone soft. Yet the only really surprising thing about it is that it should be such a big surprise. It again proves, however, one inescapable fact: That the best engineering in the world is of no value if you can't sell engineering's products.

Recently we checked with three prominent producers to find out who was buying their tremendous output. Not one of the three really knew. Two "guessed" between 70 and 80% was going to operators, the rest to private owners, the third said his planes were going about 50-50 to operators and individual purchasers. All three were among those amazed that they suddenly had to cut production.

A successful dealer—who wasn't taken aback at the turn of events—has an idea on the subject that's quite a challenge both to top management and to engineering. He says it's just possible the market's lousy because there simply isn't a *real* small personal plane available yet. When he found it took as much sales effort to sell a small plane as any other, he put his stress on a four-place job and is doing right well, thank you, selling to businessmen who use the craft in their work as well as for pleasure. Incidentally, one man ordered one just two days after his brother-in-law had been killed in a transport crackup.

Personal aircraft utility still stays with us as a problem. And not all the blame for its lack can be hung on the engineers—it still takes airports to operate airplanes. So, it's more than a little discouraging to hear that CAA has had to request communities to apply for funds under the federal airport act. But maybe some of the blame for this community lethargy must come right back to the industry itself. Remember what the automobile industry did to get more and better roads built? That industry went out into the grass roots and did a job—for out in the grass roots was where it sold its products.

What's Goodyear going to do about that two-place amphibian? The question has popped up all over the lot, and here's the answer: Goodyear built the first craft—and will build several more—to learn everything possible about the field. Right now the company is in what might be called "the process of active engineering." Only after it has thoroughly tested the craft and studied all the angles will there be a decision as to whether or not the winged foot symbol will become a permanent part of the personal plane field.

Election of a Republican Congress has certainly done a job of curing a flock of industrialists' ulcers, and everyone sincerely hopes said ulcers stay cured. But, just in case anyone in the industry has gotten fond of little Alfred the Ulcer, there's plenty with which to keep him happy. And if NAA chapters, Chambers of Commerce, or any civic minded group wants a good job to do, there'll be plenty of opportunity. For, in at least a dozen state legislatures there are strong chances that aviation gasoline taxes will be proposed. And if you think much—or any—of such taxes will ever be used for aeronautical purposes, just check the history of all the taxes you've paid on your automobile gas. If anyone wants a good long fight—for a very worthy cause—just drop in at the state legislatures.

Speaking of Congress, this 80th in our republic's history has a wonderful opportunity to record itself among the best if it does only one thing—establish an air power policy for these United States. It's hard to think of anything that would do more to aid the diplomats in their tough struggle for an honest peace, or anything that would do more to stabilize the industry which will be called upon to maintain our air power. It may be hoping for too much in the way of statesmanship, but such a policy must be established. The industry can certainly help itself by letting the Congress know about it.

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What's New

In Products and Practices

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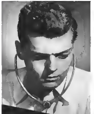
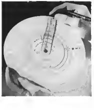


Simpler, Lighter Headphone Set.....1

Suitable for use by commercial aircraft pilots and flight control operators, new type of electro-acoustic device, made by **Telex Inc**, Minneapolis, is worn under chin rather than over head. Designed like a stethoscope, set has two hollow Tenite tubes stemming from a small round speaker and is adjustable to proper head widths. Ends of tubes are tipped with clear Tenite ear pieces. Entire unit, including speaker and plug-in cord, weighs 1.2 oz, thus reducing ear pressure and head fatigue. Set is stated to have accurate high-fidelity reception, plus durability.

Avigation Aid 2

Developed for use with air almanacs, new calculator made by **Sillcocks-Miller Co.**, South Orange, N. J., is designed to determine local hour angles and meridian angle "t" of any star, planet,



sun or moon at any time of day, at any point of longitude. It may also be used for solving other time and arc problems encountered in celestial avigation. Instrument consists of five disks of vinylite plastic rigid sheet so pivoted that they can be rotated independently, and a transparent handle marked with a meridian line which is radial to graduations on disks. Printing on calculator is protected by vinylite film overlaminated to sheets.

Handy Airbase Crane..............3

Featuring portability, ease in handling, and flexibility for varied lifting jobs, new 1-ton gantry crane made by **Industrial Equipment Co.**, Chicago, is reported to incorporate a large safety factor with minimum of weight. It is seen suitable for a variety of uses at airfields and aircraft maintenance centers. There is up to 8 ft. head room to hoist hook, depending on type of

hoist used, and 10 ft 8 in inside lower end of legs. Crane is designed to be easily dismantled and stored. Weight without hoist or trolley is 595 lb

Easy-Handle Map Case.............4

Incorporating a strip map mounted on two rollers, "Rolaire" map case has been designed to enable most convenient reference by pilots in cross country flying. Made by **Rolaire Engineering Products**, Los Angeles, its case is 12½ x 10 x 1¼ in. and it weighs 37 oz. On standard roll of maps, prepared for any one area, coverage will probably include all flying done by 95% of pilots in that area. Unit is designed to take a total of 22 ft of maps on one roller. This map may be made up of 4,000 mi. of regional or route charts, 2,000 mi of sectional maps, 8,000 mi.

of direction finding charts, or any combination of these types of maps, plus a sectional planning chart. If any particular non-standard combination of maps is desired on any roll, such a roll can be prepared by pilot, himself, from directions furnished with case, or can be purchased from dealer or company. Rolls are loaded camera fashion. Plastic face of case is specially treated so pencil notations and calculations can be made on it and can be erased with soft eraser. Internal lights are provided for night avigation, with a rheostat to control light intensity. A tab at end of map sections gives distance between all principal cities on route, with magnetic course out of any of these cities to all others tabulated on form. Mileage scales are placed along edges of plastic face and can be used to measure short distances from cities shown on tab form.

Cuts Airline Cooking to Seconds....5

Based on use of magnetron tube, employed in wartime radar new electronic range, "Radarange", made by **Raytheon Mfg. Co.**, Waltham, Mass., cooks in a few seconds foods which under normal conditions take many minutes or even hours. Pre-cooking preparation is same as in cooking on standard stove except in case of frozen foods, in which case no thawing is necessary. Frozen food is put under heating unit and merely a few seconds added to cooking time. Of first two production models offered, one is for use aboard airliners—a model capable of handling complete meals. Food would be pre-cooked, balanced in heat load angles, and placed in disposable

dish which fits into food compartment of range. Under this plan frozen meals can be placed in refrigerator and put in heating range when required. Radar cooking may be compared with diathermy heating, but with concentration of heat made possible by horn and magnetron. Unit consists of a power supply, a magnetron unit, and an applicator or horn through which energy from tube is beamed and concentrated on food. Two push buttons and a timer which automatically shuts off unit at proper time are all controls necessary. Unit is fused and equipped with safety switches. Range will be offered in variety of sizes and models to meet varying specifications of airlines.

Airline Casseroles 6

Designed to provide hot meals to passengers while in flight, new galley equipment offered by **Air Associates**, Teterboro, N. J., consists of casseroles, available in both aluminum and china,

which hold portions of meat, vegetables, and other foods, cooked and ready to serve hot. Stainless steel vacuum container houses casseroles in a rack, one on top of other. Hot casserole lifter is included. China hot food container has five casseroles with china cover and weighs about 14 lb. Set in aluminum includes six casseroles and weighs about 11 lb.

Versatile Lock Wrench.............7

Incorporating double lever or toggle action permitting tool's use as a combination straight, end, or pipe wrench,

vise, toggle press, clamp or pliers, new locking hand wrench made by **A. C. E. Inc.**, Detroit, is stated to have a gripping strength equivalent to 1-ton pressure. It can be used as a clamp on such operations as welding, soldering and pattern making. Made of alloy steel and cadmium plated, wrench is 10 in. long and has jaw opening of 1¼ in.

Amplifier for Strain Gages 8

Providing amplification of 25,000 from 1 to 30 cycles, new strain gage amplifier made by **G. C. Wilson & Co.**, Chatham, N. J., is stated to give a substantial visual indication of vibration amplitudes of 00001 in. when used

with a suitable strain gage and a cathode ray oscilloscope Unit and associated electronically regulated power supply consist of six radio-type tubes and components housed in a metal cabinet Operation is from 115v., 60 cycle supply and requires 150w

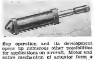
Airfield Utility Wheels 9

New line of rubber tired steel utility wheels for aviation service and general airport use, is announced by **Palmer Mfg. Co.**, Cleveland Employed is

specially designed wheel-mounting device which omits cross axle. Stated to have stood vertical load tests of over 1 000 lb, wheels can be used on mobile fire fighting equipment, acetylene tank carts, dollies, engine racks, and mobile cradles. Solid rubber tires are mounted by special process to eliminate tire loosening or slippage on rims. Wheels are sold in 6½ and 8 in. dia, either in sets of four with stamped steel assemblies included, or individually with both ½ and ⅝ in. bushings

New Linear Actuator 10

Made in same dimensions as hydraulic jack of like operating capacity, new electric motor-operated linear actuator is now being produced for a leading aircraft manufacturer by **Electrical Engineering & Mfg. Corp.**, Los Angeles Unit was designed especially for wing



flap operation and its development opens up numerous other possibilities for applications on aircraft. Motor and entire mechanism of actuator form a self-contained unit, with only outside elements being three connecting wires. It has been designed for an average operating load of 3,500 lb tension and compression, and is stated to withstand a static load of 8,000 lb. tension and 12,750 lb compression, with ultimate load of 25,000 lb compression Jack speed at average load is ¼ in per sec, and length of travel is 4 in, with longer stroke if desired Motor is 28v, d.c, 31 amp, intermittent type Output at average load is ½ hp Weight is 10 lb, 11 oz.

Precision Screw Comparator 11

Recommended for builders of fine instruments and for related industries where thread inspection is necessary on screws of diameters ranging from 060 to 216 in and threads of 80 to 28 per inch National form 60 deg. Model C comparator announced by **Pratt & Whitney Div., Niles-Bement-Pond Co.**, West Hartford, Conn. uses

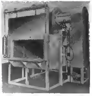
J-S gaging principles with a pressure control feature which relieves operator of responsibility of judging borderline cases. Signal light shows result of full "go" and "no go" functional check on pitch dia, minor dia, lead, and angle. To operate, screw is placed in work holder, where it is held on its major dia Operating lever is depressed and screw is presented to gaging rolls Light remains on, except when excessive pressure is applied, at which time light goes out. This feature is designed to provide accurate and sensitive pressure control—important due to small size of screws being checked Gaging pressure is adjustable to suit work

Aircraft Heating Duct 12

Ranging from 1 to 6 in dia and up to 6 ft long, "Multi-Flex", a non-metallic hot air aircraft duct for heating systems of planes, stated to weigh less than half of aluminum tubing and capable of conveying air at temperatures up to 500 deg, has been developed by **U. S. Rubber Co.**, New York City New duct is made of glass fabric impregnated with heat resistant rubber and plastics

Electronic Inspection Gage 13

Made in sizes up to 3 in. with 1 in. range in each size, new electronic snap gage for production inspection, made by **Yankee Precision Products Co.**, Hartford, Conn., incorporates gage head mounted on snap frames. Unit can also be mounted on stand Gage is operated on 110v., 60 cycle, single phase current. Larger than 3 in. sizes can be furnished, and if readings are wanted, provision has been made to mount indicator in top of frame instead of plug



New Alloy Furnace 14

Utilizing atmospheric type burner mounted on lower end of duct which is used for recirculating air back into furnace, new batch-type furnace for heat treating aluminum alloys is announced by **Bellevue Industrial Furnace Co.**, Detroit High temperature fan is used for recirculating heated air Method of heating is stated to hold temperature with very little variation Burner is mounted in duct to eliminate extra heating unit.

Sparkplug Wrench 15

Operating on friction-disk principle, new Model SPW "Trutorq" sparkplug wrench is announced by **Airdraulics Engineering**, New Canaan, Conn Torque prescribed or recommended by plug or

motor maker can be preset on wrench by turning dial on wrench head to setting indicated. Wrench is 8½ in overall and weighs 6½ oz. It has forged aluminum handle and stainless steel or cold rolled adjusting head. Structure of head is reported unaffected by dust, oil, or gasoline Tool is calibrated with four settings for cast iron and aluminum heads, 10 mm, 14 mm, 18 mm, and ⅞-18, equivalent to 0 to 50 ft-lb of torque. Tool is equipped with standard ½ in socket drive to fit standard sockets

Thread Checker 16

Having adjustable truncated cylindrical gaging anvils which are stated to make possible checking of thread lead within a range of 4½ to 60 threads per inch to an accuracy of 0 0001 in. on production parts such as aircraft components, new "Leadcheck" thread-checking instrument is announced by

Sheffield Corp., Dayton, Ohio Unit may be had with either of two types of gaging heads, one being a "tenth" dial indicator for lead tolerances within indicator range, or an electrical gaging head, developed jointly by Westinghouse and this company, for more accurate gaging where lead tolerances are as narrow as 0 0001 in. Adjustable truncated cylindrical gaging anvil can be

(*Turn to page* 140)

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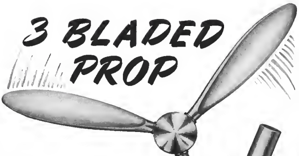

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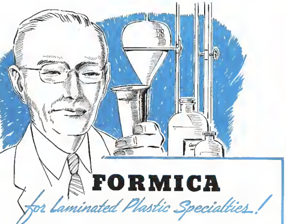

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NOWHERE ON EARTH is the cost of a man-hour of labor as high as in the United States. The cost of an hour of labor has increased beyond belief during and since the war. It should be obvious to those who sell their time that no mathematical magic will keep the price at present levels or above, unless each precious hour produces enough goods to be sold at a reasonable profit. That isn't economics. It's simple common sense. Unless labor increases its productivity, the so called gains of labor will be losses in the long run.

But management has a responsibility, too. It is to provide the ingenuity and planning and machines to make each hour of labor count. And this applies not only to production plants but to maintenance shops. That is why tooling is stressed so heavily in this, AVIATION's Tenth Annual Maintenance Issue.

In the pages that follow you will find many specific examples of retooling to save valuable man-hours. Among them are an engine parts cleaner that represents a substantial capital investment, but it enables 3 men to do the work of 40. Another labor saving device is a cradle, designed by two maintenance men, to transport engines by plane. It saves the 10 to 20 man-hours now required to crate and uncrate the engine.

Not all of the ideas for time saving presented in the pages that follow are based on large expenditures for capital equipment. Many of them are little things, often gadgets invented by the workers themselves.

Under the grim incentive of war the workers in aviation plants devised gadgets and methods that saved hundreds of thousands of man-hours annually. We know, because we edited WINGS, a magazine whose function was to seek out these ideas and make them available to other men and women in other plants.

In wartime the enemy is concrete and is therefore more real to all of us, but there is an intangible foe that lurks over us even in peacetime. It is economic catastrophe. Defeat at its hands means depression and want. Victory means lasting prosperity and a new high in living standards which even now is within our grasp.

Management must continue to exercise ingenuity in planning and invest capital in labor-saving machines for both production and maintenance. Labor must cooperate by performing an honest day's work and contributing its best ideas to make each man-hour more productive.

Work For the New Congress

THE WILL OF THE PEOPLE has expressed itself, and accordingly many new faces will haunt the Capitol halls when the 80th Congress goes into session. But those same halls will be haunted by many old problems—problems as yet unsolved. Near the head of the list is the need for a national air power policy.

Our air power problem has grown too big and too complicated to be solved by such steps as the formation of a new Air Coordinating Committee. The time has come for a more searching study of the subject by an impartial non-partisan body whose interests are high above public office. After this survey is completed it will be time to provide for an implementing agency.

The new majorities in Congress should spend little time in celebration of their victory. It is in the high public interest that they roll up their sleeves at once and lay the groundwork for a program that will regain and maintain dominant air power—not to wage war but to preserve the peace of the civilized world.

Leslie E. Neville
EDITOR

Aviation-Air Transport

MAINTENANCE AWARDS for 1946

Our 10th annual tribute to the men and women of the maintenance departments who, by their ingenuity, skill, and untiring work, have been in such great measure responsible for the constantly improved safety and efficiency which have contributed so much toward making America's air carrier system the finest in the world.

TWA
TRANS WORLD AIRLINE

H. W. CROWTHER

Trans World Airline maintenance employees headed by H. W. Crowther are cited for the 1946 AVIATION-Air Transport Maintenance Award for outstanding performance and development among airlines operating more than 10,000,000 revenue plane-miles annually.

It is recognition not only of their skilled use of new and specialized tooling provided by management but also of their resourcefulness in developing new techniques and devising and constructing new mechanical aids which have raised their own—and consequently the line's—efficiency and safety.

This marks the second time that TWA maintenance workers have won the judges' accolade for they took top honors the first year the award was announced.

WESTERN AIR LINES

WILLIAM MAXFIELD

Western Air Lines maintenance employees headed by William Maxfield are cited for the 1946 AVIATION-Air Transport Maintenance Award for outstanding performance and development work among airlines operating up to 10,000,000 revenue plane-miles annually.

WAL maintenance workers' peacetime load has proved even heavier than it was during the hectic war years, for new aircraft and new schedules have been added in far greater measure than have new equipment and space to use it. These factors, coupled with an unusual short-flight operation, have brought myriad problems to be solved by Western's service and overhaul workers. Theirs is an enviable record of raising efficiency and safety as well as volume of work handled.

ROBINSON AIRLINES
Route of the Air Chiefs

JACK PARKER

Robinson Airlines maintenance employees headed by Jack Parker are cited for the 1946 AVIATION-Air Transport maintenance award for outstanding performance and development work among the nation's regional and feeder airlines.

These maintenance workers have established, in their first 21 months of operation, a record of having had every one of four different types of aircraft ready for every schedule. This record has been made in the face of sharply increased schedules and traffic loads in working quarters which, because of material shortages, have been but of a temporary nature.

This is the first time the Award has been made to regional and feeder air lines, comprising a new and important segment of our air network.

Slick

RUSSEL L. WAGENACK

Slick Airways maintenance employees headed by Russel L. Wagenack are cited for the 1946 AVIATION-Air Transport Maintenance Award for outstanding performance and development among contract carrier organizations.

Sharing with management the firm conviction that the air cargo business is here to stay, Slick maintenance workers have made possible high aircraft utilization and establishment of an outstanding record of "delivering the goods" on time. Backed by tooling which has made possible "factory" type maintenance, these workers have nevertheless shown the ingenuity and aggressiveness so essential to successful air transportation.

This year marks the first time that the award has been presented to employees in the contract cargo field.

A W A R D W I N N E R

Scale model of TWA's Constellation "work deck" first of which is scheduled to be in operation within the month at Kansas City overhaul base. Designed as cooperative venture by several TWA departments, dock eliminates miscellany of stands, platforms and ladders.

TWA Improves Maintenance Through Better Tooling

By LEE SPRUILL, *Superintendent of Maintenance Planning, Trans World Airline*

TWA finds specialized equipment—both purchased in open market and designed in its own shops—pays off as new and more aircraft types are added to fleet.

A WAY BACK in the Stone Age men began to seek tools which would enable them to do a job easier, more quickly, and with better results. Even now—thousands of years later, when machines do much of man's work—we are still searching for new tools and equipment to lighten our burden further—and to care for the machinery already serving mankind.

This constant drive for increased efficiency through the development of improved tools and equipment is especially noticeable in the air transport industry, where even the oldest hands are still learning and where the business' headlong, youthful growth today is constantly outmoding what was learned yesterday.

Every addition of a new aircraft type to an airline's fleet or acquisition of a new maintenance facility establishes a new frontier for an operator. Though he's been in the business 20 yr., he again becomes a pioneer, progressing by instinct as well as by knowledge.

Through his own trial and error, and aided sometimes by the experience of others, he steadily tightens his grip on the new problem and emerges with a satisfactory solution.

But that is only the beginning. Once a new aircraft has been put into operation or a new maintenance base completed, then begins the long, tedious process of eliminating the "bugs" from the operation. And this task almost always involves the necessity for new tools, gadgets, and machines.

TWA has had more than its quota of these problems this year because of three major factors. First, the Lockheed Constellation was put into scheduled service both domestically and internationally early this year; second, the company assumed occupancy of the mammoth North American B-25 bomber modification center at Fairfax Airport, Kansas City, Kan., converting it into the system's main overhaul installation; and third, TWA moved all its international division maintenance activities to a newly acquired base at Newcastle Airport near Wilmington, Del.

Thus, within the space of a few months, it became necessary for TWA engineering and maintenance personnel not only to become familiar with the largest and fastest air transport in the world today but to plan and equip two huge maintenance bases to care for the new Constellations, the Boeing Stratoliners, and Douglas DC-4s and DC-3s.

In starting operation of the Constellation, the first of the postwar transports, our company was largely on its own. This was especially true in the field of maintenance and overhaul. The need for strict economy eliminated the possibility of relying wholly upon Army maintenance experience, which was hardly sufficient for our purpose anyway.

So we started practically from scratch. And we learned a lot the hard way. In fact, we still find a new solution to a "Connie" problem almost every day.

Experience with the Constellation indicates that one of the outstanding maintenance and overhaul needs now and for the future is an adequate tailor-made system of work stands and platforms for hangar and ramp use. The larger and more complex aircraft become, the greater will be this need.

Although we had been aware of it before, handling Constellations in our hangars emphasized the fact that use of a miscellany of stands, platforms, ladders, and scaffolds wastes man power, creates hazards to personnel, and frequently is a cause of damage to the aircraft itself. The necessity of stringing electrical extension cords and air hoses to the various stands resulted in a maze of lines on the floor which made neat and orderly work areas impossible. A study by TWA's industrial engineering department showed that as much as 40% of a mechanic's time is spent locating and positioning the stands or ladders needed to perform certain jobs.

Dock Projected

Consequently, in conjunction with our engineering laboratory, we began the development of a Constellation work dock especially designed to provide the most efficient working conditions possible. Dozens of persons familiar with various phases of the problem were queried, and scores of designs were sketched, constructed to scale, and discarded before a final mockup was eventually accepted. The accompanying illustration of the scale model work dock shows how completely this dock—to be ready within the month—will answer the problem.

Pursuing this policy of making the maintenance equipment fit the aircraft, we recently developed a specialized engine change tool cabinet for use on the Constellation's Wright 3350 engines. The cabinet contains all the tools and other equipment, such as safety wire, needed for the operation—nothing more. We also designed a tool apron for mechanics working up in the nacelle—an apron which carries all the tools he needs for the task at hand.

These developments are only two small results of a broad study of our Constellation overhaul operations being made by our shop and equipment development group under A. E. Jordan.

Recent improvements in engine change procedure growing out of this study, together with the use of the new tool cabinets and aprons, have decidedly reduced the time required to change all four Constellation engines—from 300 man-hours down to less than 100. Jordan's group currently is reviewing other phases of the overhaul operation, looking toward a complete streamlining of the whole task.

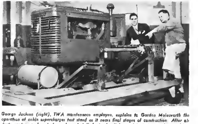
Numerous other tools and pieces of equipment have followed the Connie into our shops. For instance, we adapted a tow-motor with special overhead arms for removing and installing engines and propeller assemblies. Then our engineers designed a new propeller sling especially fitted for handling propellers on tricycle landing gear aircraft where the engine crankshaft is horizontal, and the tow-motor was adapted to use this sling.

Another device designed and built in our shops was a special power egg dolly for Wright 3350 engines. Also developed at our Fairfax base was a jig designed to check alignment of the power egg mounting ring.

The man-hour savings resulting from adoption of these tools and equipment is as yet difficult to determine accurately. But we know that each one has proved its worth many times, and each contributes to the efficient operation for which we are always striving.

Necessity for better tools is especially emphasized by the swing to larger and more complicated aircraft. In the engine overhaul phase, for instance, 1 hr. of Constellation operation necessitates the same amount of overhaul work as 6 hr. of DC-3 flight.

The comparison is arrived at this way: We overhaul a DC-3 engine every 900 hr., a Constellation every 600 hr.



George Jackson (right), TWA maintenance employee, explains to Gordon Molesworth the operation of cabin supercharger test stand as it nears final stages of construction. After air ducts, venturi, and control panel are installed, stand will be used to test supercharger drive-shaft-universal joint units which run cabin pressurization on TWA's Lockheed Constellations.

So far every 3600 hr of flight we overhaul two DC-3 engines four times each, making a total of eight overhaul operations, while with a Constellation we overhaul four engines six times each, totaling 24 engine overhauls. Connie engines, moreover, have twice as many cylinders, and overhaul requires roughly twice as many men and twice as much floor space as on a DC-3 power plant. This amounts to a 6-for-1 workload ratio.

Consequently, development of better tools to speed this overhaul operation will also reduce both the space and manpower required. And still another benefit will be a reduction in the number of spare engines necessary for the airline's operation.

The Big Job at K. C.

Planning and outfitting of our huge Kansas City overhaul base was a tremendous job in itself. We had more than 427,000 sq. ft. of hangar, shop, and office space under one roof. In that space we had to establish a maintenance and overhaul facility capable of handling a fleet of nearly 100 aircraft, including at the outset 18 Constellations and five Boeing 4-engine Stratoliners. The DC-4s flown by our international division were overhauled at the Newark base, later moved to Wilmington.

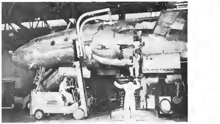
Last August the engine overhaul section moved into the base from Kansas City Municipal Airport to complete occupancy of the installation. Though our plant layout plans worked out quite satisfactorily, we have nevertheless found it expedient to make several changes since full-scale operation of the base began.

Here again the search for tools and equipment has been both urgent and continuing. In addition to the usual reasons for wanting improved tooling, we had conservation of space to think of. With floor space at the base valued at $18 per sq. ft., we were vitally interested in cutting corners, literally as well as figuratively.

One change of this sort now being carried out is modification of tool cabinets, especially in the engine overhaul shop, involving substitution of sliding doors for conventional doors opening outward. Streamlining of assembly lines also helped to conserve space.

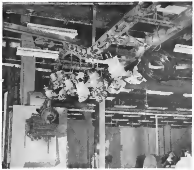
Outstanding among the new equipment added at the Fairfax base is the mammoth mechanical engine parts cleaner, dubbed by mechanics the "washing machine." Through its 300-ft. long tunnel, engine parts stacked in baskets or hanging on hooks suspended from an overhead conveyor travel slowly through an 8-stage cleaning operation requiring about 9 hr.

Recent example of improved tooling is this jig, designed to check alignment of mount ring structure assembly of Wright 3350 engine used in Lockheed Constellations. Here Project Engineer R. V. North shows how alignment check—made after unit has been assembled and just prior to final power egg assembly—will disclose any defect in ring alignment. Visible (lower left) is tubular structure of power egg dolly designed and built in overhaul base.

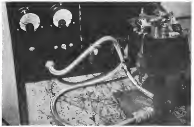


Workhorse of TWA's Kansas City overhaul base is this specially built tow motor equipped with overhead arms. Employed primarily to install power eggs and propeller assemblies, it has been found useful in many other heavy duty procedures.

First machine of its kind to be put into operation by any airline, the huge system was installed at a total cost of nearly $100,000. Justification for this outlay is the fact that three men operating the cleaner can turn out the same volume of engine parts as a crew of 40 men did under our old system. In addition to this manpower saving, the "washing machine" does a better job than the old vat system, and its speed can be regulated to coincide with the remainder of our engine overhaul operation.



Baskets of engine parts and group of cylinders hanging by hooks on overhead conveyor are shown entering TWA's 300-ft. long mechanical engine parts cleaner recently installed at Kansas City overhaul base. Some 9 hr. later these parts will emerge from this "washing machine" with which three men do work better than could formerly be done by 40.



In constantly improving maintenance tooling, TWA buys when it can, builds when it can't. And when it builds, ideas usually have come from alert maintenance employees. Typical of such devices is this propeller governor holding fixture. An electric governor head with cover removed is fastened by two clamps (one of which is visible) to specially designed metal stand which facilitates both repair and testing of unit.

Recently added to our machine shop is a 25-ton, 36-in. metal lathe which we believe is the only one of its kind operated by an airline shop. It was most valuable in reworking engine blower housings to accommodate two-speed blower installations now on all of TWA's Constellation engines.

The company's employee suggestion plan has brought forth literally dozens of improvements in both procedures and equipment used in our overhaul and maintenance operations. Though our analysis of these suggestions is quite strict, many are accepted, and cash awards to the employees submitting them are sizable. Many of these awards amount to several hundred dollars; one employee received a $1,000 War Bond for his very helpful contribution.

This incentive plan keeps the ingenuity and inventiveness of each maintenance employee alive and results in a continuous flow of ideas from the men who are actually doing the work.

TWA's tooling policies are probably little different from those of any other airline; we are always looking for a way to do a job more quickly, more economically, and with less manpower. Any tool or piece of equipment which promises to achieve one of these goals receives careful scrutiny.

"Buy or Build" Plan

Our policy is to determine, after careful study, exactly what we need in the way of tools or equipment and then try to buy them ready-made, so to speak. If the tool or device we require isn't available in the open market, then we have it designed and built in our own shops. We buy if we can; if we can't, we build.

Naturally we strive for standardization of all maintenance equipment throughout TWA's 28,000-mi. system. For this facilitates economical purchasing, aids in training personnel, and simplifies maintenance of the equipment itself.

As a step toward this standardization, our *Standard Tool & Equipment Catalogue* is now nearly ready for publication. This volume will contain a photograph or drawing of each item used in the hangars and on the ramps at our line stations, together with its description, what it's used for, where it can be purchased, and other pertinent information.

The engineering and maintenance phase of TWA's activity, under V.-P. J. C. Franklin, has chalked up important accomplishments during the last year, despite the existence of obstacles which at times seemed almost insurmountable. We have tried, meanwhile, to plan effectively for the years immediately ahead.

But even if our plans, based on conditions today, were perfect, we could not rest for long, because we will be busy trying to keep up with the constant change which will probably typify our industry for a long time to come.

A W A R D W I N N E R

WAL's Maintenance Work Rises in Peacetime Operations

By SCHOLER BANGS, *Pacific Coast Editor, 'Aviation'*

Western Air Lines found that addition of new planes and more schedules, without added working space, posed many difficulties—but these have been counterbalanced by ingenious shop-built devices. And future plans call for further work simplification through "floating stockrooms".

RETURN TO PEACETIME OPERATIONS has meant little in the way of peace to Western Air Lines' maintenance employees. In fact, reconversion to the postwar era has meant, not a change to an easy going life, but to one which has called for ever greater vigilance and hard work.

For the coming of peace brought not only increased schedules, but new and larger equipment requiring new maintenance techniques, while—at least initially—there has been no increase in working space.

To move engines from buildup shops to waiting planes, Eric Griffith designed this heavy-duty trailer, which was built by Callahan Engineering Co. In addition to two fully builtup engines, trailer carries ramp for stand, tripod derrick that fits into trailer bed, and hand winch

Western's operating technique is unique in that it requires bringing practically the entire fleet of 30 planes—including 12 DC-4s and 13 DC-3s—home to "bed" at Lockheed Air Terminal every night. Recent addition of the DC-4s, and new schedules, has resulted in daily maintenance operations covering a half-mile-square area. Planes are spread over a length of parking line that requires use of five separate stockrooms for turn-around servicing alone.

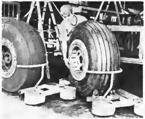
Added to these conditions are the facts that a majority of the line's planes are engaged in short trips, in which a single plane may carry the burden of making as many as six separately-hooked flights in one day. A single mechanical delay of any consequence is able to disrupt that plane's service utility for the entire day—and throw off schedule not one but all flights beyond the one charged with the delay.

Meanwhile, WAL's 650-odd maintenance employees look forward to the move next spring to Los Angeles Airport and, by comparison, "cushy" quarters—quarters and tooling tailored for an even flow of work and a minimum of lost time.

For example, Western's maintenance chief, William Maxfield, has designed and now has under engineering development for shop-wide use the first commercial airline adaptation of a "floating stockroom."

Under this system a maintenance man reporting in for work will find awaiting him a tiered wheel-mounted parts rack with everything he will need to carry him through his particular project. The rack will have been filled by stockroom clerks before his shift, even going so far as positioning of the parts for use sequence, with each numbered for positive identification. A work order and any required special instruction sheet will be an integral part of each rack.

This simple though logical device is expected to eliminate costly time losses of the stockroom waiting line. The mechanic will be able to concentrate, without interruptions for part hunts,



When Western bought war surplus portable wheel racks they were found to hold tires too firmly. Noble Brewer maintenance inspector, suggested welding small rollers on base support arms so one man—as Mike Morales demonstrates—may easily rotate tires for inspection

When propeller governor pulleys caused time losses through early loosening on shaft, insertion of steel bushing in pulley shaft solved problem. WAL went step beyond, designing prop governor cable interchangeable between DC-3s and DC-4s, as shown by Eric Griffith

Western's maintenance chief, William Maxfield, designed sparkplug carrying case to reduce damage risks. Provided is a container that can be easily sealed by cord of maintenance service tag and which stacks easily in sparkplug dryout cabinet as Ralph Cook shows

This painter's tray is experimental example of "floating stockrooms" WAL will use when operations are moved to Los Angeles Airport. C. 9. Crawford (left) and J. W. Darling, show how all needed supplies for a given work project will be brought directly to job

Quick location of proper areas for work and equipment saves time. Western achieves it by outlining special work and equipment areas on hangar floor in yellow paint so that both aircraft and required docks and tools can be quickly spotted

on the job he is doing. By the same token, stores clerks in the main stockroom will be free from interruptions so they may maintain their supply shelves and fill waiting trays for work that lies ahead.

Another development, in the blueprint stage, will bring tools right to the plane. All WAL aircraft will be fitted with a fuselage sidewall fitting for connecting a heavy duty vacuum cleaner outside. Then cleaning crews need only take into the craft a short length of vacuum hose that will attach to the interior plug-in of the connection, and thus it will be unnecessary to lift into the plane heavy equipment or cumbersome lengths of hose. The shorter hose will provide greater working flexibility and reduce cleaning time.

Such maintenance planning, coupled with employee-devised time-and-labor savers (shown in accompanying illustrations), can only mean more efficient maintenance that will be reflected not only in the operations statistics, but in the balance sheet as well.

This one didn't originate in line's shops but WALers agree it's good practice. It consists of removing thermocouple tube splice in engine oil line to give better oil flow. New thermocouple is introduced directly into engine block. On left, the old, right, the new.

Engine cradle (center) was developed to carry replacement engines by plane to outlying points on WAL system. Made from conventional engine buildup stand (right) cut down to fit into C-47, it saves from 10 to 20 man hours usually devoted to crating and uncrating. Eric Griffith (photo), chief mechanic in charge of buildup William Nee and Jeff Conklin designed it.

This shop-devised agitator, powered by small electric motor, takes backaches and headaches out of cleaning oil tanks as John March shows. Tank is strapped into position in welded frame, then filled with 5 gal of Turco Products Surjex. After 2 hr of tumbling it is drained and given 1½ hr washing with 3 gal of Union Oil Co No 5 cleaner. Water rinse follows.

Rigid blast tubes on DC-4 engines used to shake generator covers loose within 300-400 hr. Covers were a loss, and fire hazard was created. Here Mechanic John March shows replacement of metal blast tube with flexible Airtron hose. Vibration has been observed no covers have been dislodged.

Mistake saver is this plane time board mounted prominently on work floor of Western's main overhaul hangar. Reports on board are maintained from pilot flight reports filed in binders on table beneath. Oliver Noonan, chief mechanic, is shown entering a shop time record.

WAL experienced serious abrasion of de-icer boots caused by dragging of fuel hose along DC-4 leading edge in reaching outer wing tanks. To get to these tanks directly, Carl Falkens (on ground) set up this lightweight steel tube ladder. It was built in Western shops.

Venders Are Important, Too

While giving full credit to employees who devise maintenance aids, Western Air Lines recognizes the vital part played by often-unsung suppliers of parts and specialty items so important to maintenance department efficiency.

Even search of the line's purchase records doesn't produce a complete list, but the following tabulation presents a cross section of firms and their products which participate in WAL's maintenance.

Foxboro Products, Newark, N. J.	Air filters, calibrating instrument test
Sterling Electric Motors, Los Angeles	Machine to check breathing systems on DC-4
Aircraft Accessories Corp., Kansas City, Kan.	Propeller governing test unit
Ross Carrier Co., Benton Harbor, Wash.	Ross lift trucks
Kennedy Kits Mfg. Co., Van Wert, O.	Tool boxes
Walker Turner Co., Plainfield, N. J.	Drill presses
Hewlett Packard Co., Palo Alto, Cal.	Audio signal generator
Allen B. DuMont Labs, Passaic, N. J.	Cathode-ray oscillograph in radio testing
General Radio Co., Cambridge, Mass.	Secondary frequency standard for radio testing. Test output frequencies of sets on ship and on ground
National Receiver Co., Malden, Mass.	Frequency standard sets for radio testing
Ideal Laboratory Tool & Supply, Cheyenne	Turn-and bank test stand
L & R Mfg. Co., Newark, N. J.	L & R cleaning machine for instrument repair
General Motors (Ternstedt Mfg. Div.), Detroit	Directional gyro indicator (on plane & testing)
H. C. Thompson Clock Co., Bristol, Conn.	Instrument used for pressure testing of instruments. Timer for gyro movement
Acro Supply Mfg. Co., Cerry, Pa.	Poppet valves, gaskets, wobble pumps
Aero Tool Co., Burbank, Cal.	Dimple die sets, rivet sets
Aeroquip Corp., Jackson, Mich.	Nipples, sockets, nuts, hose, self-sealing coupling half
Aeronautical Services, Washington, D. C.	World air charts, route charts, U. S.
Adel Precision Products Corp., Burbank, Cal.	Cartridge assembly, filter color slide viewer, motor assembly
Cochran & Carbon Chemicals Corp., San Francisco	Isopropanol alcohol
Champion Spark Plug Co., Toledo, Ohio	Sparkplugs for DC-4s
Consolidated Vultee Aircraft Corp., San Diego, Cal.	Steel stock carts, wooden flap racks with casters
Bendix Aviation Corp., South Bend, Ind.	Condensers & bearings, gaskets, bushing, carburetors, stewardess handset, glass-beadless pilot jack mase jue box. Microphones, remote control, box accessory kit
Bendix Radio (Div. of Bendix), Baltimore, Md.	
P & B Corp., New York City	Sparkplugs for DC-3s
Douglas Aircraft Co., Santa Monica, Cal.	Tubing, auto pilot control assembly, Rubber seals, cable gov flap assembly
E. I. DuPont De Nemours & Co., San Francisco	Dulux Dope (paints)
Ducommun Metals & Supply Co., Los Angeles	Stainless steel (commercial grade) stainless tubing, steel wires
Firestone Tire & Rubber Co., Los Angeles	Aircraft tires & tubes, wheelbarrow tires, mfr aircraft tire, case airplane tread
Elgin National Watch Co., Elgin, Ill.	Aircraft clocks
B. F. Goodrich Co., Glendale, Calif.	Tubes de-icer, de-icer shoes, stabilizer lower, fin de-icer, tires, fire prevention hose
Hayes Industries, Jackson, Mich.	Brake assembly frames inner & outer spring assembly, brake adjuster
Fuller Brush Co., Los Angeles	Fiber brooms
W. P. Fuller & Co., Los Angeles	Benzine, lacquer thinner, paint
General Electric Supply Corp., Los Angeles	Feathering switches, unit heaters
General Petroleum Corp. of Cal., Los Angeles	Aviation oil, gasoline
General Veneer Mfg. Co., South Gate, Cal.	Flooring, stripping for WAL floor
Lewis Engineering Co., Naugatuck, Conn.	Electric temperature instruments thermocouples, sparkplug DC-4
Linde Air Products Co., San Francisco	Presto-O-Lite dissolved acetylene aviators breathing oxygen
Liquidometer Corp., Long Island City, N. Y.	Tank units & indicators
Pacific Metals Co. Ltd., Los Angeles	Welding torch, tip cleaners, Alcoa alum. sheets
Pratt & Whitney Aircraft Div., East Hartford, Conn.	Engines
Pesco Products Co., Cleveland	Couplings, body, gaskets, Pesco engine driven vane type fuel pumps
Radio Corp. of America (RCA Victor Div.), Harrison, N. J.	Radiotrons
Radio Television Supply Co., Los Angeles	Electronic parts & supplies, rotary ICA switches
Service Steel Co., Detroit	Stainless steel tubing
Sperry Gyroscope Co., Great Neck, Long Island, N. Y.	Instruments, gyro horizon
Standard Oil Co. of Cal.	Cleaning solvent
U. S. Rubber Co., Los Angeles	Fire resistant hose, U. S. Royal tires
Turco Products	Surjex

Western-built DC-4 hydraulic cowl flap test stand, built by John Culley, weighs only 45 lb. Hand pump charges its lines up to 3,000 psi. Attachable in 5 min., it carries accumulator, gage, and 4-way valve, plus numerous outlets. Frank Neal (left) and William Cheney, put it through paces.

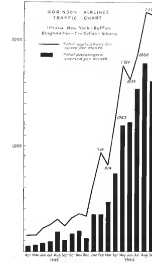
Good vendor designs have prominent place in Western shops. This is Douglas' own cabin heater test rig. Two 25-hp. electric motors provide air blasts up to 120 mph for heater tests, as shown by E. C. Reed (atop cabin), Walter Cruikshank (holding tube), C. J. Owens, and C. B. Crawford.

L. W. Burgess, WAL electric harness overhaul specialist, found suspension of harness wiring by cords during repair was awkward. He developed metal harness jig (which he demonstrates) to hold wires firmly in position. A metal arm supports main harness lead wires in convenient working position.

A W A R D W I N N E R

Robinson Meets Schedules The Hard Way

By JOHN FOSTER, JR., *Managing Editor, "Aviation"*



This is the traffic load with which Robinson Airlines' maintenance department kept pace in temporary quarters without ever delaying flight because of mechanical trouble. Bars show traffic moved; line above shows applications for seats. Temporary drop in September was due to change from daylight to standard time, necessitating completion of day's flight earlier because present field does not permit night flying

Here's how Robinson Airlines sharply increased regional service—through four aircraft types — despite severe shortages of many kinds.

MAINTAINING FOUR DIFFERENT TYPES of aircraft for over a year in strictly temporary quarters without ever having delayed a schedule is a record which gives great pride to Robinson Airlines' maintenance department.

This record has brought with it greater responsibility, for it is the department's prime desire to keep the slate clean and to do it in the face of more frequent schedules—there are eleven a day through Ithaca—even before moving to permanent quarters

Getting the planes to the flight ramp on time for every schedule has been no easy task, for New York State's first regional airline has literally grown from scratch in the face of practically every type of shortage

Robinson Airlines started operations 21 mo. ago as a result of Pres. C S Robinson's firm conviction that his home town of Ithaca, N. Y.—and the neighboring tri-city communities of Binghamton, Endicott, and Johnson City—were entitled to, and would support, a frequent schedule air transportation system east to Albany and New York City and west to Buffalo

Initially the line's equipment consisted of three Fairchild 24s which had been specially fitted at the Fairchild factory. Shortly afterward a Cessna Airmaster was taken over from Robinson Aerial Surveys to help meet a tremendous week end traffic demand brought about largely by business from Cornell University students and faculty members

Since the operation had always been planned as a regional, scheduled operation conforming to all CAB regulations, two Cessna T-50s were acquired to provide twin-engine equipment

The mechanics of servicing the new type craft were taken in stride, but a lack of hangar facilities made the work increasingly difficult, especially during inclement winter weather. And shortages of building material didn't help

However, enough material was obtained to construct a temporary hangar designed to house two Beechcraft 18Ss—of which four had been previously ordered. This hangar is a double-T affair, with Maintenance Superintendent Jack Parker's office, shop, and storeroom set under a common roof between the two T's Labor shortages were so severe when the hangar was constructed that maintenance personnel themselves poured the concrete (in each side of the hangar) to provide apron type flooring in the areas which would be beneath engine and empennage of the aircraft being "worked"

Robinson Airlines schedules are arranged so that three planes depart in quick succession at 7:45 A.M.—one westbound to Buffalo, and two eastbound, one to Albany and one to New York. All three craft make quick turn-arounds at those points, arriving back in Ithaca between 10:30 and 11, when the day crew runs regular preflight inspections and handles any work called for by flight crews. During the winter months, because of limitations imposed by the present airport facilities, the day's schedules are completed by 5 P.M., when the night maintenance crew takes over for the major portion of the work

Aircraft and engine logs are made in duplicate, the forms providing space for "squawks", which are immediately jotted on the copies which are turned over to the maintenance department. These sheets are always examined as soon as possible, so that the matters can be discussed with pilots before they leave the field

During the past few months three Beechcraft 18Ss have been flying a total of more than 600 hr. per month, so that 100-hr. checks about once a week have become routine. Since it was impossible to purchase much of the equipment necessary for this work, Superintendent Parker designed and supervised construction of some of the more essential items, as shown in the accompanying illustrations.

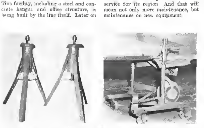
While the present temporary quarters at Ithaca have proved adequate for all necessary airframe work—including such items as complete rebuilding overnight of a damaged flap—the facilities are not felt equal to major engine overhauls. Until new quarters are available, therefore, these overhauls will be done at the Teterboro, N. J., base of Robinson Aviation, parent company of the airline. Radio service and instrument repair and overhaul have also been routed to Teterboro.

And in each case the line has been able—by diligent searching—to find spare units so that quick changes could be made to keep the aircraft meeting schedules

Main reason the line's present quarters are temporary is that a new field is now under construction at Ithaca. This facility, including a steel and concrete hangar and office structure, is being built by the line itself. Later on it is expected Cornell University will participate as it expands its aeronautical engineering college

The move to the new field later this winter will be a mixed blessing for the maintenance department. Better quarters will naturally make some of the work easier, especially during rugged weather. But, moving will also mean that schedules can be expanded to include night flying—not yet possible on the present field—and this, in turn, will require more preventive maintenance and overhaul work, and at more frequent intervals.

Even this impending move might well be considered temporary for, assuming the CAB grants the line a certificate in the Middle Atlantic Case, Robinson Airlines plans additional service for its region. And that will mean not only more maintenance, but maintenance on new equipment



Typical of tools designed by Maintenance Superintendent Jack Parker are these airframe jacks for running 100-hr. checks on landing gear. Units at left were made of jack screws, which were purchased from house mover for $13.60 and cut to fit into frames made of scrap metal. Purchased units would have cost $400 if they'd been available. Tail jack (right) cost $26; consists of two Hein Werner bumper lifts welded to metal frame set on casters salvaged from heavy safe.

Temporary double-T hangar at Ithaca Municipal Airport. Note heat ducts from Mor-Mac gas heater leading directly to engine nacelles to keep engines warm during winter months. Portable Stewart-Warner engine heater is used for planes which are left on flight ramp.

AWARD WINNER

Slick Features Factory-Type Maintenance

This contract carrier scoured nation to insure proper tooling as means of keeping big fleet of cargo carriers out of shops and in the air. Policy has paid off in high utilization.

By RUEL McDANIEL

Portable heater developed by Slick maintenance department to employ in C-46E cargo space as protection for perishable cargos during winter operations

OPERATION PERFORMANCE of the contract carrier is only as satisfactory as its maintenance, and maintenance depends largely on the tools and equipment available for routine maintenance. This is the firm belief of the management of Slick Airways, one of the nation's outstanding contract all-freight carriers, with headquarters in San Antonio, Tex.

The company operates ten Curtiss C-46E Commandos, completely converted to commercial cargo haulage, each with a freight capacity of a little better than 11,000 lb. Its plane utilization averages about 9 hr. daily, and its load factor is 70.1%.

This high utilization factor is due in considerable extent to the company's maintenance system and the equipment at the disposal of the maintenance force, for the Slick main maintenance plants contain approximately $500,000 worth of equipment. The shops have all equipment necessary to rebuild not only engines but completely rebuild its planes when necessary, according to Earl F. Slick, 25-yr-old president of the company.

Starting just a year ago from merely an idea, the Slick organization purchased nine of its planes from Government surplus and one from a private owner, then began the major task of converting them for cargo work, even before details were completed for a permanent site from which to operate. The company shortly afterward acquired a long lease on a former Army field and most of the buildings of the field, including the hangar.

It put its first converted cargo carrier into the air with a full load on Mar. 4 of this year, and freight volume has since risen consistently, until today the line turns away business for lack of sufficient planes to handle the volume.

Russel L. Wagenack, for 5 yr. with Airplane Division of Curtiss-Wright as assembly superintendent, and with commercial airline experience, took over as maintenance superintendent of Slick in time to supervise the conversion work on all planes and in ample time to help select maintenance equipment and lay out the shops.

"We have tried to combine some of the best features of factory routine with maintaining our cargo planes," Wagenack says. "As a result, our maintenance costs on these C-46Es are almost as low as average maintenance costs on DC-3s—smaller planes having less cargo capacity."

Backbone of Slick maintenance is inspection routine, covering these nine definite steps:

1. *Turnaround inspection.* Made at end of each transcontinental trip, this is a visual inspection of plane, engine, and all accessories. Obviously any work found to be needed on this or any other inspection is handled at once.

2. *Regular 100-hr. CAA inspections.* These checks may be made either at San Antonio or smaller maintenance plant at Long Beach, Cal.

3. *Progressive overhaul.* Covering everything but engine, this is carried out when and as planes are available for the work.

4. *Regular 800-hr. engine change.* Removed engine is replaced by one previously pulled from another plane and overhauled and sent to engine "pool." Engine goes to engine shop, where it takes its turn for complete overhaul and transfer to engine pool. At same time, maintenance crew also removes and overhauls all major accessories, such as propeller, generator, and carburetor.

5. *Major 3,600-hr. plane overhaul.* This also includes engine overhaul. Airframe receives a complete check and overhaul, as do all accessories and mechanisms.

6. *Painting*, which is carried out progressively as needed and as planes are available.

7. *Exterior polish* for all surfaces of each plane, every 200 hr. Wagenack reports he has found Bon Ami and hand polishing most satisfactory routine for this operation.

8. *Greasing and lubrication*, completely every 200 hr.

9. *Oil change, every* 400 *hr.* Company does not have equipment for refining used oil, but it is considering possibilities.

Maintenance is unitized, either in separate, adjoining buildings or sections of shop buildings. The 11 shop maintenance units include: Main airplane overhaul shop, engine overhaul shop, machine shop, radio shop, magneto testing room, carburetor shop, engine assembly room, instrument shop, engine testing plant, steam cleaning plant, and metal shop.

Completely-equipped machine shop at Slick Airways' main maintenance base at San Antonio is housed in former Army barrack. Getting such equipment necessitated nationwide "shopping tour" but was considered well worth effort to uphold company's desire for sound maintenance.

Obtaining needed equipment for the various units of the maintenance plant in itself was a tremendous job because of the scarcity of new equipment. The company shopped the country over and uncovered some new units, which it bought direct from manufacturers or distributors; it found some new Government surplus units; and it purchased some used Government surplus. Equipment in the main plant at San Antonio, the smaller shop in Long Beach, and three out stations—at Newark, Denver, and Chicago—cost more than $500,000.

The main airplane overhaul shop handles propeller and generator overhauls, in addition to performing other airplane repairs. The shop has an Aircraft Accessories Corp. test stand to adjust the governor to hold the engine to the correct rpm. on takeoff, also propeller-balancing ways.

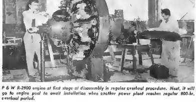
Other maintenance units in the propeller section of this shop include a Denison Engineering propeller test stand and a General Bronze prop dolly for moving and storing propellers.

Among additional major units in this shop are: Malabar Tool & Machine wing jack set, Spencer Turbine vacuum cleaner for plane interiors, Mallory Electrostarter for supplying 24v. current to planes on the ground, Leonard Tubemaster for working tubing in planes, Singer sewing machine for working upholstery and draft-curtains, Alemite grease gun, 110v. motor generator set for use on ramp, Turco high-pressure cleaning unit which is hydromatically operated and uses a dolly, heat-checking unit to gage heat of blower and motor on grounded plane, Ford towing equipment, and an International unit for northern work.

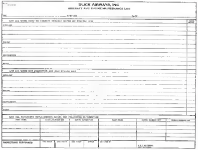
The engine overhaul shop occupies an entire Army barracks building, and another unit is being built onto it to double the space for this department, so that an "assembly line" routine may be more fully developed.

Among the important units here are: Barnes Drill Co. honing machine, for working inside the engine and cylinders, Sioux valve-seat grinder, Kwik-Way valve refacer, Magnaflux unit for testing all steel, two Sly sandblast units, crankshaft holding fixture, Detrex vapor degreaser, complete engine test stand, for checking before overhaul and testing after reassembly, and Steammaster steam cleaning unit to furnish steam for degreaser and tanks. All engine units are steamed and

With eleven Curtiss C-46E Commandos in service—and utilization exceeding 9 hr. daily—Slick Airways operates its own instrument shop at San Antonio headquarters.



P & W R-2800 engine at first stage of disassembly in regular overhaul procedure. Next, it will go to engine pool to await installation when another power plant reaches regular 800-hr. overhaul period.



Slick Airways aircraft and engine log developed by Maintenance Superintendent R. L. Wagenack has space for pilot 'squawks' on one side, with reverse side listing all work done to correct troubles. Additional space is given for mechanics "to list all work not corrected and give reason why"—a feature which has greatly increased department's efficiency.

cleansed of grease before being disassembled.

In the machine shop, equipped to produce any emergency part needed, are such units as: Despatch heat treating oven, Wilson hydraulic press, Cincinnati moulding machine, Norton surface grinder, Do-All saws, South Bend and American lathes, and a Cincinnati drill press. A Stromberg flow bench is the main unit of the carburetor shop.

The magneto shop has such equipment as Denison magneto testing assembly, Pesco test stand for checking vacuum and hydraulic pumps, U. S. Veridrine hydrostatic test stand, Testometer furnished by U. S. Electric Motors, general test stand for checking voltages and current relays, and Jack & Heintz hand testing stands. The company overhauls all major accessory units, such as magnetos, carburetors, and generators, with each engine change.

Sparkplugs are handled at a bench in the radio room, being removed from planes, checked, and adjusted every 100 hr. The line uses a BG-RB-19 platinum plug. Shop checks all radios at the end of each 100 hr. of use. All major bases maintain one or more Clark Fork trucks for utility work around the hangars and ramps.

Superintendent Wagenack has devised an aircraft and engine log sheet which not only has simplified pilot reports but has aided in double-checking on recommended adjustments or necessary work which is to be done on the plane.

The log is printed in triplicate, with the original, of course, remaining at all times in the plane. One copy goes to the main office and one to Wagenack.

Front of the log sheet contains printed spaces for the pilot to report all essential facts of his flight and to note difficulties encountered from any units during operation. Maintenance copy goes immediately to the superintendent, if the report is turned in at San Antonio, and to the head mechanic if at another point; and the remarks noted by the pilot govern the work to be done.

The mechanic then lists on the back of the log all work performed to correct the troubles noted by the pilot. Below the space for this listing there is a special space for the mechanic to list all recommended work which he did not do, and to give his reasons why he did not do it.

"This latter feature has done more than anything we were ever able to do before to prevent a mechanic's slighting minor work, especially at repair shops outside headquarters," Wagenack declares.

Inspection Procedures For Turbojets

By IRVING STONE, *Assistant Editor, 'Aviation'*

For top reliability in maintenance of aircraft's new-era power plant, a detailed understanding of the exacting inspection methods are necessary. Here are basic concepts of jet plant trouble shooting and comprehensive A-to-Z check points for engine components.

Careful and methodical inspection procedures—so effectively proven as the prime prerequisite for efficient maintenance of reciprocating engines—warrant additional emphasis in the maintenance routine for the modern turbojet power plant with its closer tolerances and higher operating temperatures and speeds.

Like the conventional engine, malfunctioning of the jet power plant may be classified under two broad headings—(1) Troubles whose origins are readily determined with an understanding of operating principles, and (2) those which require considerable investigation and a thorough knowledge of engine makeup and interrelation of parts.

In the first-mentioned classification of malfunctioning, corrective measures are generally applied after the remedial inspection procedure of trouble shooting. The second classification frequently involves disassembly and special equipment.

While gas turbine jet engines vary in some degree in basic design and features of construction, fundamental inspection procedures will be found to be generally applicable to all.

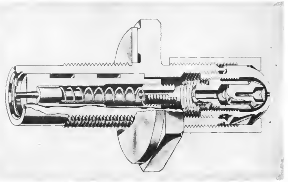
In our chart (see page 54) of turbojet troubles and remedies, some of the more common causes of turbojet operating difficulties are listed together with their probable causes and attendant remedial inspection and maintenance.

Complete examination of a jet power plant—such as the General Electric I-40—to determine the serviceability of each component requires detailed inspection procedures in a clean shop with air-filtering facilities to remove dust. Benches should be covered with clean paper, and illumination provided to permit discernment of fine cracks. Magnetic and fluorescent penetrant (black light) equipment are also required.

The following step-by-step tabulation covers A to Z procedures on components of the turbine, compressor, and accessory drive assemblies. Called for is detailed inspection of—

A. Combustion Chambers.

1. Flame tubes for burns, cracks, distortions, loose clips, or loose fins.



Sectional view of typical fuel nozzle assembly. Tip is at right, and barrel surrounds spring and pin at left.

2 Tube interconnectors for burrs, cracks or distortions

3. Welded seams of ring and tube assembly for breaks, particularly seams around outer cross over tubes.

4. Flanged faces of outer tubes for defects.

5. Ring and tube assembly under black light as follows:

a. Coat inner surface with fluorescent penetrant.

b. Allow to stand for 5 min. or more for penetration.

c. Then check outer surface under portable black light (in booth or darkened room) for signs of penetrant, which will have seeped through any cracks. Penetrant will show as luminous line or area.

B. Nozzle Diaphragm

1. Nozzle diaphragm for cracked, burned, distorted, or damaged blades.

2 Sealing baffle drop from exit edge of nozzle blade on inner spacer ring, placing straight edge across inner spacer ring and measuring distance to each sealing baffle with depth micrometer. (Refer to manufacturer's table of limits.)

3 Sealing baffle around inner ring of diaphragm for bends, distortions, or cracked welds.

C Cooling Air Diffuser Check for rubbing or breakage. Inspect under black light as follows:

1 Dip diffuser in penetrant and drain for at least 5 min

2. Rinse off excess penetrant with fine water spray.

3 Dip diffuser in liquid developer for black light inspection and dry in heating booth.

4 Use black light in dark room.

5 Wash off developer with water spray.

D Sparkplugs

1. Porcelain for cracks

2 Bushing around porcelain for firm seat

3. Welded joints between electrodes and sleeve.

4 Joint between mounting pad and sleeve for cracks.

5 Spark gap (Refer to the table of limits)

E Fuel Manifold

1. Joints and seams for cracks

2 Coupling nuts for cracks or damaged threads.

3 Manifold for dents or distortions.

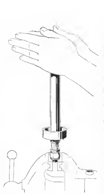
4 Flares under coupling nuts for damage.

5 Manifold by hydraulic-test as follows:

a. Plug each manifold connecting tube with suitable fittings

b Connect two ends of manifold ring with standard T-fitting

c Connect kerosene supply line to



Honing nozzle orifice in pattern-testing procedure

bottom of T, then test manifold under 600 psi

d Check outside of manifold for leaks, especially at silver-soldered joints.

F Drain Manifold

1 Joints for cracks

2 Coupling nuts for cracks or damaged threads

3 Flares under coupling nuts for damage

4 Drain manifold by hydraulic test as follows

a Plug each manifold connecting tube with suitable fitting

b Connect one end of manifold to kerosene supply line, and plug opposite end.

c Test under 100 psi

d Check outside of manifold for leaks, especially at silver-soldered joints

G Turbine Bearing Support

1 Bearing support casting for cracks or breaks by filling oil passage channel with fluorescent penetrant; check for external surfaces leakage or defects

2 Sliding case sleeve for defects

3 Tie rods and clevis and tie strap assemblies for damage

4 Pressure oil and scavenge oil tubing for damage

5 Oil jets for dents or other damage check size of each jet orifice (Refer to table of limits)

6 Bushings for proper pin locking

7 Threaded holes for damage.

H. Turbine Front Bearing Assembly—Inspect retaining nut, sliding ring, and adjusting nut for defects

I Turbine Rear Bearing Assembly

1. Grooves of turbine oil seal for defects

2 Measurement of i.d and o.d of oil seal in at least two positions, 90 deg apart Use 3- to 4-in. i.d. and o.d micrometers

3 Bearing housing for defects.

J Turbine Rotor Assembly

1. Rotor and shaft by black light method as described for "cooling air diffuser" Allow at least 15 min. of penetration

2 Shaft, especially splined portion, for pickups or burrs

3. Rotor buckets for burrs or cracks

4 Threads at end of rotor shaft for burrs

5 Coupling sleeve and turbine coupling hub for pickups or burrs Inspect parts magnetically

6 Spacer and oil deflector for pickups or burrs Inspect parts magnetically

K Air Adapters and Nozzles.

1 Adapter castings under black light for cracks or breaks

2 Adapter mounting face for burrs

3 Tapped holes in adapters for damage

4. Bushing in adapter nozzle support boss for roughness, pickups, or burrs.

5 Fittings for damaged threads

6 Supports on domes for broken welds

7 Domes for dents or distortions

8 Nozzle body for damaged threads or burrs

9. Nozzle, as follows:

a Place nozzle in soft-jawed vise with tip up, and remove tip

b Place tip in socket fixture on vise and make sure swirl is tight, using screwdriver

c Screw fixture from pattern test stand into tip

d Secure fixture in vise with tip up, and hone tip orifice lightly with special tool by screwing tool down over tip, twirling handle of tool between palms, and lightly pressing center fixture for a moment against tip. Use lightest possible pressure in performing honing operation

e. Install tip and fixture in pattern test stand and connect fuel line

f Check tip by operating test stand until liquid reaches high mark on one of glass tubes

g If pattern is uneven, remove tip and place it in socket fixture on vise

h Remove swirl, using magnetic screwdriver

i. Hone inside of tip orifice with special internal hone.

j Repeat pattern test

k. If pattern is unsatisfactory, remove tip and swirl Place swirl in vise fixture up to circumferential ring. Rotate retainer approximately 45 deg in either direction with screwdriver.

l. Repeat pattern test, and continue preceding adjustments until satisfactory result is obtained or tip rejected.

10. Nozzle flow, as follows:

a Remove locking ring from inlet end of nozzle, then remove barrel assembly by tapping hex-nut flange with plastic hammer. Keep barrels in sequence so they may be re-installed in nozzle from which removed

b Place fixture from flow test stand in soft-jawed vise with fuel line fitting down. Insert nozzle (minus barrel) with tip up Tighten with box wrench

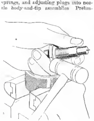
c. Place a complete set of nozzles in stand

d Bring inlet supply pressure up to 200 psi. and allow flow to continue for 10 sec at this pressure Variation between any nozzle in set should not exceed 20 c.c.

e. If nozzle body and tip assembly does not meet foregoing conditions, replace unsatisfactory tips and repeat procedure until complete set of nozzles is satisfactory.

f. Remove spring and metering pin from each barrel by unscrewing adjusting plug, and install only metering barrels into nozzle body-and-tip assemblies. Test in flow stand under conditions specified by manufacturer If any of assemblies does not meet these conditions, replace unsatisfactory metering barrel and repeat procedure until complete set of assemblies satisfactorily passes test.

g Reassemble metering pins, springs, and adjusting plugs into nozzle body-and-tip assemblies Preliminary estimate on loading of spring can be determined by aligning plug stake mark with barrel stake mark



Removing barrel assembly from nozzle in flow test procedure

h. Test complete nozzle assemblies in the flow stand under conditions specified by manufacturer. If any of complete nozzle assemblies does not meet these conditions, flow may be varied for pressures up to 50 psi. by replacing metering pins. For pressures above this value, flow may be varied by adjusting metering plug to change spring loading

i. If nozzles pass this test satisfactorily, stake metering plugs in place and lock nozzle tips to nozzle bodies by bending metal over flat of hexagonal surfaces

j. Set nozzles in clean container pending assembly into proper air adapters

L Compressor Casings

1 Front and rear casings for cracks or breaks, using black light procedure outlined for "cooling air diffuser"

2 Inner surfaces of front and rear casings for burrs or rough spots

3 Bushings for proper pin-locking

4 Threaded holes for damage

M Compressor Diffuser

1 Diffuser for cracks or breaks, using black light

2 Diffuser for roughness or burrs.

3 Diffuser bushings for proper pin locking

4 Threaded holes for damage

N Compressor Bearing Supports

1. Support castings for cracks or breaks, using black light.

2 Bushings for proper pin-locking.

3 Threaded holes for damage

4. Sliding case sleeve for burrs

5 Oil jet for dents or other damage; check size of jet orifice (Refer to the table of limits)

6 Guide vane for dents or damage

7 Each compressor bearing support channel by filling with fluorescent penetrant and inspecting exterior under black light

O Compressor Front Bearing Assembly

1 Oil seal grooves for burrs

2 Measurement of i.d and o.d of oil seal, using i.d and o.d micrometers (Refer to the table of limits)

3 Sliding case sleeve and adjusting nut for pickups or burrs

P. Compressor Rear Bearing Assembly

1 Bearing housing for burrs or pickups, and retaining washer and grooves for burrs

2 Oil seal for out-of-round

Q Compressor Rotor Assembly

1 Impeller for cracks, especially around studs, using fluorescent penetrant and black light.

Unscrewing adjusting plug from barrel assembly.

2 Impeller blades for burrs

3 Impeller for bent or damaged studs.

4 Front and rear shafts, especially bearing journals and shaft shoulders, for pickups or burrs. Use magnetic inspection on front and rear shafts

5 Threads on front and rear shafts for burrs.

6. Alignment of shafts.

7 Compressor coupling hub and oil deflectors and spacers for pickups or burrs

8 Shaft locknuts for stripped threads.

R Trunnion Supports.

1 Supports for cracks, using magnetic inspection

2 Support threads for evidence of stripping.

S Truss Rings and Guide Blades.

1 Truss rings for cracks, using fluorescent penetrant and black light.

2 Joining surfaces of rings for burrs.

3 Rings for warpage, using surface plate and dial indicator.

4. Guide blades for bending.

T Accessory Case

1 Case for cracks, using the black light procedure as outlined for "cooling air diffuser"

2 Studs for tightness and for right angles to case face.

3 Bearing housings in case for roughness or burrs.

U. Accessary Drive Gear Cage.

1 Cage for cracks or breaks, using fluorescent penetrant and black light

2 Bearing housings in cage for burrs, scoring, or roughness.

V Shaft Spacers and Shafts

1 End faces of shaft spacers for burrs.

2 Bores of shaft spacers for roughness

3 Ball-bearing journals of gear shafts for roughness or defects.

4. Keyways on gear shafts for burrs

5. Keys for snug fit

6 Threads on gear shafts for burrs

7. Shafts for defects, using magnetic inspection.

W. Gears and Pinions.

1. Gears and pinions for signs of uneven wear.
2. Teeth for burrs.
3. Teeth for breaks or cracks, using magnetic inspection.
4. Center bore of gears and pinions for pickups.
5. Gear and pinion hubs for burrs.

X. Main Drive Shaft and Clutch

1. Splines of main drive shaft; also clutch housing for burrs.
2. Clutch pawls for signs of excessive wear.
3. Edges of clutch pawls for nicks, burrs, and roughness.
4. Clutch pawls for binding in housing or on pawl pins.
5. Compression and tension of clutch springs for conformance to manufacturer's values.
6. Clutch housing spring holes and contacting face of drive shaft locknut for burrs.
7. Shafts and clutch parts for breaks or cracks, using magnetic inspection.

Y. Oil Nozzle. Inspect oil nozzle for security in starter gear shaft.

Z. Bearing Locknuts, Screws, and Plates.

1. Contacting face of ball bearing locknuts for burrs.
2. Bearing locking screws for stripped threads.
3. Contacting face of bearing retaining plates for burrs.

CHART OF TURBOJET TROUBLES AND REMEDIES

I. Failure of Unit to Start

Probable Cause	Remedy
Fuel system	
Lack of fuel	Fill tank and repair possible leaks in piping or tank.
Improper fuel	Drain and fill with fuel of recommended specification and grade
Dirty filter	Replace
Improper throttle	For unit to start throttle must be fully open and, on starting, returned to ¼ position
Selector valves	Check position.
Barometric fuel control	
Sticky control valves	Replace barometric.
Ruptured bellows	Replace barometric.
Faulty main control valve seat	Replace barometric
Starter- or main fuel-pump inoperative	Replace.
Relief valve on starting fuel-pump discharge	If stuck, tap lightly. If broken, replace
Check valve in main-fuel discharge	If stuck, tap lightly. If broken, replace
Check valve in starting-fuel-pump	If stuck, tap lightly. If broken, replace
Electrical	
Starter control fails to function	Repair or replace.
Starter	
Low rpm	Check battery
Dirty commutator	Clean commutator and replace glazed brushes.
Clutch pawls or ratchet broken	Replace unit
Ignition	
Dirty sparkplugs	Clean and readjust gap.
Broken electrodes	Replace sparkplugs
Defective sparking terminal insulator	If sleeve is cracked, replace plug
Improper sparkplug gap	Set gap according to table of limits
Defective wires	Repair or replace.
Coil functions improperly	Replace.

II. Low Manifold-Fuel-Pressure—Unable to Reach Full RPM

Probable Cause	Remedy
Dirty fuel filters in air adapter	Clean or replace
Main fuel pump	Replace
Dirty check valve in starting-fuel-pump discharge	Clean or replace
Throttle setting	Check and reset properly
Governor functions improperly	Reset
Stopcock not open	Check linkage to see that valve is fully open
Fuel pressure gage inaccurate	Recalibrate
Leaks	Check lines and stop leaks

III. Low Oil Pressure

Probable Cause	Remedy
Oil filter	
Dirty filter	Clean
relief valve in filter	Clean or replace
Lack of oil	Check oil level in gear case
Clogged lines	Flush and clean
Leaks	Check piping and connection
Lube-oil pressure gage inaccurate	Recalibrate
Lube and scavenger pump (sheared drive)	Replace pump.
Lube relief valve in pump (faulty spring adjustment)	Replace or readjust spring

IV. High Oil Pressure

Probable Cause	Remedy
Cold Oil	Warm
Lube-oil pressure gage inaccurate	Recalibrate
Dirt in oil-jet screens	Remove unit for overhaul.
Plugged oil line	Locate and clean.
Improper oil	Use oil specified

V. Fuel or Oil Leakage From Drain or Drip Valve

Probable Cause	Remedy
Drip valve in fuel manifold stuck	Tap lightly to release. Remove and clean or replace
Chamber-drain valve stuck	Tap lightly to release. Remove or replace.
Determine if fuel or oil leakage	Isolate leaking accessory and replace defective unit. (Four accessories must be inspected: Control valve, governor, main fuel pump, and starting fuel pump.)

VI. High Rear-Bearing Temperature

Probable Cause	Remedy
Improper lubrication	Check lubricating system as outlined under "Low Oil Pressure" and under "High Oil Pressure."
Improper indicator reading	Check indicator and thermocouple
Bearing failure	Replace unit.

VII. High Exhaust-Gas Temperature

Probable Cause	Remedy
Improper firing of combustion	Check nozzles for proper functioning and chambers for firing
Improper fuel	Check fuel grade and specification.
Bucket wheel and diaphragm	Check for proper condition of buckets and nozzle diaphragm.
Faulty tachometer indicator (overspeeding)	Replace indicator or recalibrate.
Foreign matter clogging compressor inlet screening	Clean.
Faulty exhaust pipe temperature gage	Recalibrate.
Faulty burner nozzles	Replace complete set

VIII. Faulty or No Combustion

Probable Cause	Remedy
Burning continues in one or more chambers, after shutting stop check (system flooded)	If combustion does not stop keep starter in operation and admit CO_2 to compressor inlet
Stopcock valve not sealing	Check for cause. Replace valve if necessary
Fuel nozzles out of balance	Replace entire set.
Liners touching outer casing	Remove, and repair or replace.

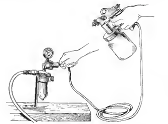
IX. Erratic or Low Speed Indication

Probable Cause	Remedy
Indicator reads backward	Reverse indicator leads.
Low indicator reading at high speeds	Check tachometer generator, indicator, and wiring

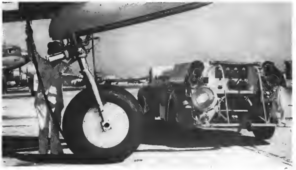
X. Excessive Oil Consumption

Probable Cause	Remedy
Loose fittings or connections	Check and tighten.
Orifice omitted in clutch shaft	Install orifice.
Excessive clearance around oil seals	Replace unit.
Drain leakage from drip valve	Isolate leaking accessory and replace defective unit. (Four accessories must be inspected: Control valve, governor, main fuel pump, and starting fuel pump.)

True Spray Pressure Obtained With Portable Gage



• Bracketed to a short length of 2 x 6 lumber, portable gage gives an at-the-work reading of pressure supplied to spray gun, also eliminates need for walk to read gage at compressor.



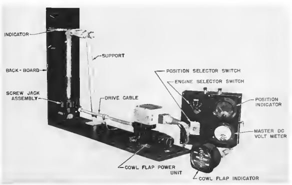
Ramp Maintenance Truck is Fast, Versatile Servicer

• Built of lightweight materials and powered with Ford V-8 engine, this rapid servicer, in experimental use at UAL's Chicago station, incorporates motor generator set with 400 amp. (normal operating load) capacity, or 800 amp. for momentary peak loads such as occur in starting engines or in using cabin air circulating motors. Other equipment includes 20-gal. tank and heater to supply hot water for aircraft's washroom facilities, 50-gal. alcohol tank for servicing propeller anti-icing system, 20-gal. hydraulic fluid tank, 100-cu. ft. nitrogen cylinder to maintain oleo strut pressure, air cylinder, oxygen tank, two 12v. floodlights with extension cables, fire extinguishers, and towing unit.

Truck is pictured in use on Chicago field apron. Builder is Conse Mfg. Co.

Simple Metal Band Eases Piston Insertion

• As aid in engine assembly, this band depressor holds rings in place during piston installation. Split band is fitted with hinged bolt which swings in or out of band fork end. Butterfly nut on bolt draws band ends together for firm seating of piston rings.



Cowl Flap Mechanism Tester Affords Pre-Installation Check

• Cowl flap power units and indicators can be advantageously checked in shop, rather than at installation, with this compact tester. Power unit is connected to screwjack assembly via flexible drive, and is controlled by three-position switch. Indicator arm on back board moves to "closed" or "open" with switch manipulation, and any variance can be corrected by adjustment of micro-switch assembly on top of power unit. After final calibration, unit leaves shop in a sealed condition, ready for installation in plane, in contrast to previous method which necessitated mechanical checking after installation—requiring at least 45 min. and involving possibility of damage to delicate parts.

Cowl flap indicator can be checked along with power unit. Selector switch gives reading for flap setting on each engine. Master d.c. voltmeter indicates operating voltage.

Mechanic Eric Haas of AA's instrument overhaul section developed device, estimated as saving $2,100 annually.

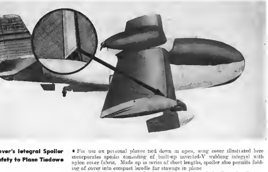
Hydraulically Raised Stand Has Automatic Step Positioning

• Constructed of welded tubular steel, this work stand provides 1,500 lb. static load capacity, and, via manually operated hydraulic pump, affords height range of 13 to 20 ft. Steps are self-adjusting to maintain parallel position to ground regardless of working angle of stand.

Unit, built by Airquipment Co., is equipped with locking casters, truck locks, and ring type tow bar.

Quickly Made Tester Checks Airspeed Indicator

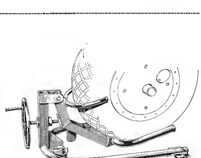
• Used for fast checkup of airspeed indicator and lines from pitot tube without need for removal, this easily constructed apparatus consists of accurate manometer connected to water canister fitted with two nozzles. With one nozzle connected to pitot tube or intake of instrument, mechanic blows into other nozzle, pressure on water in canister being same as that applied to installation under check.



Wing Cover's Integral Spoiler Lends Safety to Plane Tiedown

• For use on personal planes tied down in open, wing cover illustrated here incorporates spoiler consisting of built-up inverted-V webbing integral with nylon cover fabric. Made up in series of short lengths, spoiler also permits folding of cover into compact bundle for stowage in plane.

Cover, vinyl plastic-coated for imperviousness, is made by Bogardus Bros.



New Wheel Dolly Doubles for DC-4s and 6s.

• Designed to handle nose- and main-wheels of the DC-4 and DC-6, this dolly is mounted on three swivel casters incorporating toe-operated locking mechanism to prevent rolling after positioning. Manually operated jack-screw is provided to position wheel vertically, and jack may be used without re-adjusting other standard jacking equipment employed.

Designed by Douglas service equipment group, unit is manufactured by Aircraft Mechanics, Inc.

Aircraft Fuel and Oil Recommendations

AIRCRAFT ENGINE FUELS are presented in the universally accepted manner of OCTANE NUMBER. The number shown in FUEL GRADE column opposite any engine indicates the minimum octane number allowable for use in that engine. If grade shown for an engine is not available, use the next higher grade—never a lower grade.

ENGINE OILS for aircraft engines are recommended under three different classifications:

(1) AVIATION ENGINE OIL
(2) AN (Army-Navy) ENGINE OIL
(3) SAE Viscosity

Aviation Engine Oil is specially refined for use in aircraft engines. Each refiner provides in his Aviation Engine Oil those properties which make it suitable for that use. Each grade or viscosity is designated by a number (65 80 100 120) which is the approximate viscosity in seconds Saybolt at 210°F. Limits are usually within ± 5 seconds.

AN (Army-Navy) Specifications are expressed as 1000 Series oils and they carry the same viscosity ratings as Aviation Engine Oils plus 1000. Thus AN 1080 is equivalent in viscosity to Aviation Engine Oil 80. However AN Engine Oils carry specifications as to viscosity index, flash point, pour point, carbon residue, etc.

SAE Viscosity Number covers viscosity only and no other qualification. As the limits of SAE ranges are much wider, it cannot be said that an SAE grade is "equal" to an AN grade but it can come within the range of that grade.

AVIATION GRADE	AN NO.	SAE NO Classification
65	1065	SAE 30
80	1080	SAE 40
100	1100	SAE 50
120	1120	SAE 60

Where oils of lighter body than Aviation Grade 65 or AN 1065 are required SAE 20 is usually recommended.

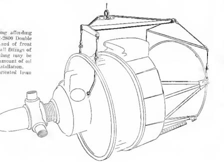
ENGINE MAKE	ENGINE MODEL	FUEL GRADE (Min.)	AVIATION OIL GRADE—Ground Temperature: Above 70°F	AN	70°F to 20°F	AN	Below 20°F	AN
CONTINENTAL	A-40-4 to and including Ser. No. 2623, and A-40-5 to and including Ser. No. 3230	73	65	1065	(SAE 20)		(SAE 20)	
CONTINENTAL	A-40-4 and A-40-5 later than above, and A-70	73	80	1080	80	1080	65	1065
CONTINENTAL	A-50, A-65, A-75, A-100, C-75, C-85, C-115, C-125	73	80	1080	65	1065	(SAE 20)	
CONTINENTAL	A-80	80	80	1080	65	1065	(SAE 20)	
CONTINENTAL	W-670-M, E-165, E-185	80	100	1100	80	1080	65	1065
CONTINENTAL	R-670, W-670 except -M	73	100	1100	80	1080	65	1065
FRANKLIN	4AC-150, -150A, -171	73	80	1080	80	1080	(SAE 20)	
FRANKLIN	4AC-176B, -176BA, -176D, -199D and 6AC-298D3	73	(SAE 20)		(SAE 20)		(SAE 20)	
FRANKLIN	4AC-176F, -199E, 6AC-264F, -298F	80	(SAE 20)		(SAE 20)		(SAE 20)	
FRANKLIN	4ACG-199H	80	80	1080	80	1080	(SAE 20)	
FRANKLIN	4A4-75-A3, -85-A3, -95-A3, 6A4-125-A3, -135-A3, -145-A3	73	80	1080	65	1065	(SAE 20)	
FRANKLIN	4A4-75-B3, -85-B3, -100-B3, 6A4-130-B3, -140-B3, -150-B3	80	80	1080	65	1065	(SAE 20)	
FRANKLIN	6A8-215-B7F	80	80	1080	65	1065	(SAE 20)	
FRANKLIN	6ACT-298J	100	80	1080	80	1080	(SAE 20)	
JACOBS	L-4, -4M, -4MB, -4MA7, L-5, -5M, -5MB	73	100	1100	100	1100	80	1080
JACOBS	L-6, -6M, -6MB, -6MBA	73	100	1100	100	1100	80	1080
KINNER	K-5, B-5, B-54, R-52, -53, -55, -56	73	120	1120	100	1100	80	1080
LYCOMING	O-145-A series	73	65	1065	*65	*1065	*(SAE 20)	
LYCOMING	O-145-B, O-145-C and GO-145-C series	73	80	1080	*80	*1080	*65	*1065
LYCOMING	O-235, O-290, GO-290, O-435 and GO-435 series except O-435-B and GO-435-B	73	100	1100	*100	*1100	*80	*1080
LYCOMING	O-435-B, GO-435-B	100	100	1100	*100	*1100	*80	*1080
LYCOMING	R-680, -B4, -B4B, C, D, E, -B6, -D6, -E2	73	120	1120	*120	*1120	*100	*1100
LYCOMING	R-680-BA, -B2, -B5, -D5, -E1	80	120	1120	*120	*1120	*100	*1100
LYCOMING	R-680-E3, -E3A, -E3B	91	120	1120	*120	*1120	*100	*1100
PRATT & WHITNEY	All Wasps prior to D1, except SC and SC1	73	120	1120	100	1100	100	1100
PRATT & WHITNEY	Wasps SC and SC1, Wasp Jr.'s T3A, SB (400 hp), SB2 (400 hp), SB3 (400 hp), Hornet T2E	91	120	1120	100	1100	100	1100
PRATT & WHITNEY	Wasp Jr.'s B2 (450 hp), B3 (450 hp), Wasp H1, Hornets EG, E2G, E3G, S5E, Twin Wasps SCG, S1C3G	91	120	1120	100	1100	100	1100
RANGER	6-390B, -390D-1, -390D-3, -440C-2, 440C-3	73	120	1120	120	1120	100	1100
RANGER	6-410B-1A, -2A, -3, 440C-4	80	120	1120	120	1120	100	1100
RANGER	6-440C-5, SGV-770C-1, -770C-1C, 770C-1B	91	120	1120	120	1120	100	1100
RANGER	SGV-770C-2	100	120	1120	120	1120	100	1100
WARNER	Scarab Jr. 50, Scarab 29, 30, 40, 50, Super-Scarab 30, 40, 50, 165, 185	73	120	1120	100	1100	80	1080
WRIGHT	Whirlwind R780ET, R760E1, R975E1	73	120	1120	120	1120	120	1120
WRIGHT	Whirlwind R780E2, R975E3	91	120	1120	120	1120	120	1120
WRIGHT	Cyclone 9F50 and F60 (R & GR 1820-F50 and F60) series Models R & GR 1820-F52, -F53, F55, F56, F62, -F65	91	120	1120	120	1120	120	1120
WRIGHT	Cyclone 9GA (R & GR 1820-G1) series Models R & GR 1820-G2, G3, G3B, -G5, -G5E	91	120	1120	120	1120	120	1120
WRIGHT	Cyclone 9GB (GR 1820-G100) series Models GR 1820-G102A, G103A, G105A, 718C9GB1 (105A)	91	120	1120	120	1120	120	1120
WRIGHT	Cyclone 9GC (GR 1820-G200) series Models 702C9GC (G202A), 728C9GC	91	120	1120	120	1120	120	1120
	Model 704C9GC (G205A) Normal	91	120	1120	120	1120	120	1120
	Take off High Blower	100	120	1120	120	1120	120	1120
WRIGHT	Cyclone 14A and BA (GR 2600 A & BA) series—Models 579C14AC1 (A3A), GR2600A5A, 585C14BA, 586C14BA	100	120	1120	120	1120	120	1120

* Manufacturer recommends use of lighter grade of oil shown for temperatures below 40 deg F. Use heavier grade shown for temperatures above 40 deg F.

Engine Sling Developed For Quick Change on DC-6

• This Douglas-designed engine sling affording rapid handling of DC 6's P&W R-2800 Double Wasps, engages hoist points forward of front row of cylinders and lugs on firewall fittings of engine mount. Hoist point of sling may be shifted fore or aft, depending on amount of oil in tank and status of propeller installation.

Unit weighs 76 lb and is fabricated from SAE 1020 steel and aircraft cable.

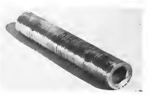


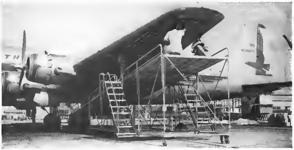
Removal of "Frozen" Sparkplugs Simplified With Special Tool

• Time and trouble formerly required to drill out sparkplug or remove cylinder is eliminated with use of this simple tool devised by Ernest Ward at PAA's Atlantic Div maintenance department.

Resembling a drift pin, unit fits over plug shank and when struck a few times with one pound hammer loosens carbonized bottom thread to permit easy removal of plug with aid of socket. Plug is discarded, but labor-savings justify its expenditure.

Formerly, as much as 1½ man-hours were required for removal operation involving broken plug complications.





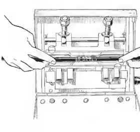
Sectional Work Ramp Speeds Maintenance

• Constructed to reduce inspection and maintenance time on EAL's Douglas DC-4s, this 67-ft. work ramp also eliminates hazard of servicing from step ladders.

Designed by Earl Chambers of line's Miami engineering department, ramp is built of 1-in. pipe and 7-ft. plywood platform comprising 5 caster-mounted detachable sections connected by U-bolts.

Slope of ramp conforms generally to wing dihedral, end height of unit in relation to leading edge is increased by removing lower section and pushing in remaining sections.

Pressurized Sparkplug Cables Salvaged With Efficient Vulcanizing



• To recondition surface-chafed pressurized ignition lead cables which would ordinarily be discarded, EAL profitably employs a special mold in this commercially marketed electric vulcanizer.

When rubber coating on cables has chafed through to copper braid core, damaged cable section is wire-buffed for cleaning and tapering. Exposed braid is wrapped with 1/32 by 1 in. uncured rubber, and after simultaneous vulcanizing and molding in machine it is as much pressure-proof as remainder of cable.

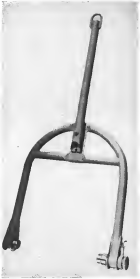
Process, estimated to save line over $10,000 yearly, is idea of J. C. Ray, engine overhaul superintendent at Miami maintenance base.

Mobile, On-the-Spot Weigher Cuts Extinguisher Inspection Time

• Routine check of over 200 50-lb fire extinguishers at PAA's La Guardia Field base has been greatly facilitated by this combination powered scooter, sidecar, and tripod scale support. Unit permits cylinder weight inspection at station location, in contrast to former slow method of carrying extinguisher back to recharging depot for check.

Tripod of ½-in chrome-moly steel has forward turned-up leg for securing in hole of sidecar floor. Top of tripod is crooked for holding spring scale. If cylinder registers proper weight, hauling back to recharging depot is obviated—even though seal is broken or safety pin pulled. Underweight cylinders are carried back to depot in sidecar.

Estimated as saving 2 hr per day maintenance time, mobile weigher was devised by PAA Mechanic Gordon Fish, seen in photo.



Controlled-Pull Tow Bar Serves for DC-4s, 6s.

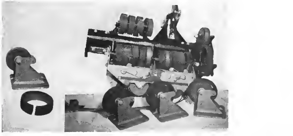
• This new tow bar—designed by Douglas for efficient ground handling of DC-4s and 6s—is fabricated from C M Steel, weighs 47½ lb., and has overall length of 72 in. Draw-bar capacity is limited to straight pull of 9,300 lb. by one shear bolt (upper, on bar attachment to yoke), while another bolt (lower) limits torque capacity to 5,100 lb. to avoid application of excessive loads while turning.

Attachment to wheel is accomplished in less than 10 sec. by inserting fixed plug in one end of hollow axle, then placing telescoping plug in other end. Spring-loaded pin drops into "engaged" or "disengaged" plug groove.

Space-Saver Dolly Tips Lightplane for Parking

• This aircraft dolly, capable of one-man operation, is designed to increase efficiency of close-pack handling of light craft to achieve greater hangar storage capacity.

Device incorporates three steel rubber-tire-equipped roller bearing casters for easy directional control, with cradles provided for propeller and landing gear wheels. Unit is built by La Ray Engineering & Equipment Co.



Scrap Rubber Hose Protects Control Pulleys

• To prevent damage to pulleys during handling or transportation, these protective caps are quickly made from scrap rubber hose. Pieces are cut in widths to fit and are left on pulleys until cable is strung.

Idea, by Douglas company's R. S. Strauss, has effected considerable reduction in damaged parts.

THE AVIATION NEWS

» What From the 80th?—Ever since the Air Commerce Act was passed in 1926, aviation as an industry has been buffeted by political winds—but too few on the tail and too many head on

What the Republican 80th Congress starts doing next month to, and for, aviation can only be surmised at this time, but certain factors stand out to give trends

Chances for unification of armed services, with co equality for air, sea, and land forces, seem as good or better than before Sen. Styles Bridges, N H., has top rights to chairmanship of Senate military committee Heir apparent to head House military committee is Rep Wallace Andrews, N Y Both are backers of merger bill

Politicos always promise to cut expenditures—as did Republicans last month—but seldom measure up Sen Robert Taft, Ohio, in line for majority leadership and chair of the Finance committee, says Army and Navy should get only total of $10-$12 billions But, if public wants strong defense forces, Congress will probably comply U S-Soviet relations over next few months will be strong influence, but forthcoming Congress will probably cut CAA appropriations heavily

Sen Owen Brewster, Me., is likely candidate for chair of War Investigating (Mead) Committee as well as Interstate & Foreign Commerce Committee to be formed as result of Congressional re organization plan Brewster has long wanted to study political influence on CAB decisions, and will probably institute an investigation Spotlight will be turned on NACA Claimant for chair of Interstate & Foreign Commerce Committee, which will handle all transportation legislation in new Congress, is Sen Clyde Reed, Kan

Rep Clarence Lea's chairmanship of House Interstate & Foreign Commerce Committee will go to Rep Charles Wolverton, N J, who, railroad supported, helped defeat Lea omnibus amendments to Civil Aeronautics Act Wolverton said Lea bill was written by Air Transport Assn lobby, promoted another one by Transportation Assn of America, pressure front for railroads Wolverton will press for integration of air and surface transport under ICC, or some new agency But high ranking member of Interstate will be Carl Hinshaw, Cal, who probably will oppose

LOCKHEED CONSTITUTION S MAIDEN HOP

Excellent proportions of Navy XR60-1 Constitution are displayed in this aerial view snapped after 92-ton giant had taken off from Burbank. Recent released performance figures give Lockheed craft 303 mph top speed at 20 000 ft., stalling speed of 80 mph and a maximum range of 6 300 mi Take off run to clear a 50-ft obstacle is placed at 4,320 ft and landing run over same height at 2 300 ft Useful load is stated to be 69 425 lb Twin decked transport can seat 168 passengers Crew numbers 12

integration and will support nonscheduled operators against airlines

Republican Congress will certainly cold-eye RFC and War Assets' handling of surplus plants—which are not selling It will pry into National Housing Administration, which supervises light metal prefab house program, of major interest to the aircraft industry It will check Administration's reciprocal air route agreements abroad, also listen to Sea-Air Committee's arguments for steamship air auxiliaries As check-and-balance, Pres. Truman still has veto power against opposition Congress

» Safety Hunt—Hoping for still more safety in flying, CAA and CAB have been meeting with aircraft manufacturers concerning proposed requirements that planes be subjected to accelerated service tests, in addition to airworthiness tests, before certification Transport types would get 150 hr test, personal models 100 hr Executive Director John E P Morgan of Aircraft Industries Assn suggests that, instead of new regulations, CAA use already-authorized Structural Failure & Defects Reports by field inspectors to improve designs

» This Year and Next—About 50% of aircraft industry's 1946 volume is civilian planes, the other military, totaling some $750,000,000 Thus military production in dollars is down to a drop in the bucket as compared to wartime volume But, while military dollar volume is small, Army and Navy air arms are spreading it thin, with two objectives To keep all major manufacturers and business available for any emergency, and to keep them all abreast of technological know how

AAF and BuAer now list more than 50 types of planes on order with 22 producers AAF's schedule will be greatly enlarged before this month is over. Its 1948 fiscal budget is under high command scrutiny, will be in Budget Bureau's hands this month Current funds will be allocated so Budget can't say AAF already has enough money.

AAF has definite orders out for at least 41 types with 16 companies, while BuAer has contracts for 21 types with 14 companies These are exclusive of some experimental craft, guided missiles, or other special projects On the books there are only one fighter and very few bombers in reciprocating engine class, and but one jet-powered AAF transport—a Curtiss C-46 conversion Navy lists only two jet fighters and one composite (jet plus recip) bomber, but other Navy jet types are in progress

Procurement program of both services includes Boeing, Chance Vought, Consolidated Vultee, Curtiss-Wright, Douglas, Edo Aircraft, Fairchild, Goodyear, Grumman, Lockheed, Martin, McDonnell, North American, Northrop, and Republic

» Getting Squashy—Light plane market has softened perceptibly, as was expected Decline in shipments undoubtedly reflects some dissatisfaction with current models, but mainly reflects working off a 5-yr backlog to point where exporters can get greater allotments Those manufacturers who feel utility is not attractive enough for continued expansion are researching for improvements while trying to increase safety, cut weight and costs Those who place faith in rotary wing and roadable types are doubling efforts, hoping to capture potential mass market.

» Surplus Off, Too—War Assets Administration has drastically reduced prices on all surplus planes except large transports List which will be furnished at any WAA district office, includes primary trainers single-engine cabins, basic and advanced trainers Ferry allowance of 27c per mile is eliminated, as is 20% discount for purchase of three Transports available include 22 C-54 (Navy R5D) and 64 C 47 (Navy R4D), in addition to 44 liaison Vet priorities apply

» Housing, Perennial Problem—Currently interested in producing aluminum prefab houses under NHA's vet program are Aviation Corp, Bell, Bendix, Douglas, Goodyear, Kellett, Martin, McDonnell, Ryan, Taylorcraft, and perhaps others Reports conflict from day to day as to who's signed up for NHA's guarantee against loss—under which RFC would buy any unsold houses Aircraft companies have facilities for working the sheet, and surplus plant space but lack distribution outlets and face problems of designing houses to meet varied requirements for different localities

» Small Returns—Of $8 47 billions lent by U S to foreign countries, only a small part will be used to purchase aviation equipment here Export-Import Bank lists but five aviation purchases as of Oct 1—$25 million to Pan American (Latin American Div) for materias, equipment, and services, $3 million to Panair do Brasil for airline equipment, $912,000 to TACA for aircraft, engines, and accessories, and $3 million to Aeronautical Radio de Mexico for communications Also approved was application from Turkish State Airways for airport equipment costing $3 million

British and French are likely to use their loans in building their own production facilities, but Dutch are purchasing twelve Convair 240s Relaxation of British Empire controls, as required under loan will permit India, Australia, and South Africa to buy U. S air products

» On Our Side Now—Germany's Kochel wind tunnels are being set up at White Oak, Md, by Navy They reach speed of M 4 4 (about 3,300 mph), high as any in this country, but test duration is very short Nazis, lacking power sources, built 52 ft vacuum sphere so that air rushed through tests into sphere

» Chance for Local Boys?—CAB examiners recommend in the Mississippi Valley case that about 5,400 mi of feeder routes be awarded in 13 midwest states, almost entirely to new operators to exclusion of established airlines Applications by Braniff, Chicago & Southern, Continental, Eastern, Pioneer, and National will be denied if Board follows examiners' proposals CAB's policy has been to give local routes to local people

» Good Looking Business—Nonscheduled operators are impressed by reports that Waterman Airlines, in flights to London, Hawaii, and San Juan, and Pacific Overseas Air lines, in trips to Shanghai for UNRRA, both without certificates, made attractive profits But other operators are unable to move into these green pastures because they can't get four-engined planes Furthermore, services may not last long, in view of CAB's pending action which might limit all nonscheduled flight operations to United States territory

» Nonsched Passenger Traffic Low—Commerce Department reports 252 nonscheduled operators flew only 16% of the passengers and 1 8% of passenger-miles of certificated domestic airlines This is a poor showing contrasted with their capture of nearly all the air freight business Nonscheds are still worrying about CAB Chairman Landis' remarks that some of them want the privileges of air transportation, but not the responsibilities CAB has yet to decide the extent to which it will continue exemption of nonscheds from safety and economic regulation

FOR BEATING A TRAFFIC JAM

Robert E Fulton designer of this neat looking combination plane and auto is seen joining components in preparation for flight Built by Continental, Inc of Danbury Conn craft seats two and is credited with 125 mph cruising speed and 45 mph landing speed It takes about seven minutes to convert into a car Six cylinder Fulton engine turns a detachable three blade prop (International News photo)

» New Yukon Gold Rush—Strife between certificated and uncertificated carriers in Alaska is even more lively than in the States, and CAB is expected to tighten restrictions on both Regular lines feel that nonscheds should be put out of business, in which case former would assume all service obligations in the area Evidently some operators who had been doing war work have barged in without CAB authority, are accused of charging both cut-throat and exorbitant rates, depending on circumstances, and of responding to radio calls intended for other flyers, sometimes picking up traffic just ahead of scheduled flights Records show 30 to 35 non certificated operators in Alaska, about 20 with authorization Now-pending consolidations, if approved by CAB, would reduce number to 15

» Against Reopening Hearings—Braniff and Chicago & Southern asked CAB to reconsider its recent decision to re open the Latin American case, in which those two airlines were awarded routes At the same time, CAB was preparing to take new evidence from Pacific Overseas Airlines, whose application to intervene in the Hawaiian case CAB had previously denied U. S Court of Appeals for District of Columbia stayed further proceedings in the re-opened Hawaii case and remanded POA's action so the Board could determine reasons why POA was late in filing its application for a route (reason was war contract commitments) Court suggested that CAB re-examine its right to re open a case after decision had been approved by the President

» PO vs Panam—Post Office Department presented evidence at hearings strongly opposing Pan American's application for trunk routes within U S Gael Sullivan, 2nd Assistant PMG, declared routes sought would duplicate "on a tremendous scale" those already furnishing service Important problem, he said, is to bring service to communities now lacking it.

» From the Shoulder—CAB Chairman Landis jolted listeners with declaration that CAB is impatient with carriers which concentrate on expansion while public pours "virulent" complaints into Washington about poor service Accidents are due for really stringent probe as to whether they are "happenstances" or are due to remediable conditions

» Freight Battle Looms—Nonscheduled and contract cargo carriers are prepared to battle certificated airlines for dominance in air freight. They have testified in CAB hearings that their energy and initiative, prodding scheduled operators into action, pushed air freight above an inconsequential trickle. Airlines will fight hard, counting on cargo to make up for declining passenger load factors, contending their combined traffic will be more economical. Slick Airways alone hit more than 2,000,000 ton-miles per month—at rate of over 24,000,000 per year—compared with a rate of 20,000,000 ton-miles for the entire certificated system in August.

» Freight Forwarder Question—CAB's freight forwarder case is biggest in its history. It may be split into domestic and overseas-foreign sections, and hearings may be scattered. Recently docket showed 89 applications from 43 companies. Since Board has no precedent, it will listen to all suggestions how freight forwarders should be dealt with.

» Canadian Notes—First Canadian-built helicopter has been readied for test flights by Engineering Products of Canada, Montreal. Craft is three-placer designed for use by Intercity Airlines, Montreal, which plans operation of 'copter service linking eastern Dominion cities.

Government's Department of Transport is installing radio instrument approach system at major airports, systems already being set up at Montreal, Ottawa, and Winnipeg and slated to go in at Toronto, London (Ont.), Calgary, and Regina.

Recent tabulation shows Canadian licensed pilots totaling 2,500, of which 1,050 are in commercial category and 700 in transport class.

AVIATION ABROAD

MEXICO—A rather remarkable situation has developed in Mexico, where the Secretary of Communications & Public Works ordered all permits held by Aerovias Braniff cancelled and aircraft of this company seized. The Secretary said this action was an outcome of recent permanent-franchise hearings which had proven "beyond doubt" that there was no need for any competition over routes now operated by CMA, Pan American affiliate, it being held that this company was giving the public more than adequate service.

This is the second time in a fairly short number of months that operations of Braniff were suspended due to cancellation of permits. Then, as now, Aerovias Braniff obtained a court injunction against this action, but this time the company is not reopening services until the matter is settled. Noteworthy is fact that Braniff has a permanent injunction from the Mexican Supreme Court against any further interference by the Secretary of Communications, but apparently this injunction was valid only for operations under so-called "experimental" permits due to expire this fall.

Tom Braniff, apparently sensing impending trouble for his Mexican venture, had earlier taken steps to Mexicanize the company. Capitalization was increased from 1 to 20 million pesos, and many prominent Mexican citizens became stockholders and members of the board of directors. Furthermore, decision not to continue operations until the incoming administration is seated is likely based on possibilities that Aerovias Braniff stands to garner more favor from the new officers.

ENGLAND—British claim to have first airliner flying on pure jet power. This is a Lancastrian serving as flying teststand, powered by two Merlins inboard and two Nenes outboard and underslung. Speed is up 100 mph. over regular version, and range is put at about 800 mi.

Air Ministry has decided to abandon all piloted supersonic developments in favor of radio controlled models. Many outstanding German scientists are now working in England, reportedly on development and perfection of German rocket plane, said to have attained a speed of 1,000 mph. Pilot was stated to have been encased in special oxygen pressure suit.

British papers now urge investigation why eastbound BOAC planes carry only an average six passengers from New York, while American lines have a three months waiting list.

DeHavilland announces it will continue tests with DH-108, one of which recently crashed, killing Geoffrey deHavilland.

Britain's aeronautical export target is $64 million a year, of which an estimated $25 million has already been booked so far, half destined for Latin America.

SWEDEN—Work is being rushed on project "1001," Sweden's bid for world speed record. It's reported design is based on German models. Plane is powered by a DH Ghost turbojet. Top speed is hoped to be around 655 mph.

Threat of a pilot's strike for SILA and other Scandinavian airlines was averted when following maximum annual rates were agreed upon: Senior captains $7,700, first officers $5,400, navigators $5,650, second officers $4,200, and radio operators $3,100.

RUSSIA—Reports that jet engines now being built in Russia under auspices of German scientists are not working out too well are seen confirmed in London report that Labor Government is allowing export of 20 RR Nenes to U.S.S.R. to form prototypes for a Russian copy.

Stalin recently stated that under certain conditions foreign airlines might operate over Soviet. However, Sweden's ABA apparently could not comply with conditions, and will have to terminate its projected Moscow route at Helsinki.

CHINA—Chinese officials report that newly formed Trans-Pacific Airlines, Ltd., now based in Honolulu, will shortly start nonsched service between Shanghai and Hawaii. Omitted in news is fact that inauguration is subject to CAB approval of TPA's application.

AUSTRALIA—Trans Australia Airlines, new Government-owned company, is planning to maintain its fares 15% below those charged by private operators. Passengers can now travel 500 mi. on TAA for $17.87.

SKYCRAFT COMPANY TESTS SKYLARK FOUR-PLACER

A personal plane newcomer—twin-boom pusher craft built by Skycraft Industries of Venice, Cal.—is seen coming in for its first landing. All-metal construction and partially retractable tricycle undercarriage are utilized. Test pilot reported no evidence of instability and low head temperatures encountered indicated that engine cooling had been satisfactorily provided.

THE LABOR CRISIS

..."Absolute power corrupts absolutely"

THE NEW CONGRESS is going to overhaul the federal laws governing organized labor. If the election returns left any doubt about that, John L. Lewis has removed it by torturing the nation with its second soft coal strike in six months.

If, however, the overhauling is to get at the roots of our labor troubles, it must go further and deeper than most of the proposals would go. Indeed, it must not stop until it has dealt decisively with that most basic cause of devastating trouble—the entrenched monopolistic power of enormous international unions, now concentrated in a handful of union leaders. Industry-wide collective bargaining is one outgrowth of this power.

"Power tends to corrupt, and absolute power corrupts absolutely." That great truth, phrased by the historian Acton, is as true of labor leaders as it is of business leaders, princes or potentates. It is also true that John L. Lewis and some of his fellow labor leaders now wield what approaches absolute power in their respective domains. Failure to recognize these facts and act on them can make a tragic mockery of the present opportunity to restore good sense and good order to our labor relations and our national life.

To realize this opportunity the labor monopoly must be made a major target.

In the minds of many people, particularly in the business community, the root cause of our labor troubles is to be found in the National Labor Relations Act, commonly called the Wagner Act. They feel that if they could get rid of the one-sided handling of a number of key labor problems provided by that act and its administrators, we would have the legislative part of the problem of creating good labor relations pretty well solved.

To be sure, there is occasion, long overdue, to balance up the lopsided treatment of labor relations by the Wagner Act and those who apply it. It has been so interpreted and applied as to deny free speech to employers. On occasion it has extended the special protection of the federal government to workers striking to force employers to break the law. It has done the same for workers striking to force the federal government to change its policy the way the strikers want it changed.

The Wagner Act has required employers to bargain with unions, but imposed no companion obligation upon unions to bargain with employers. It has given protection to workers who have broken their agreement by striking. It has been applied so as to break orderly lines of management by encouraging and giving special protection to union organization of foremen who, to do their work efficiently, must represent management. Abuses such as these should be cleaned up, and soon.

Monopoly is the Target

But if perfection were attained in eliminating all of the abuses stemming from the Wagner Act, numerous and grievous as they are, the basic problem of establishing the legislative foundations of sane and safe labor relations in the United States would by no means be solved. John L. Lewis and his fellow labor dictators would, no doubt, be annoyed, but their power would not be seriously impaired. *That power is derived from monopoly control of labor.* Just as in the case with any other kind of monopoly power, it will only be made subservient to the public interest by attacking it at the source and smashing it.

The way to do that is to apply the anti-monopoly laws to monopolies in the field of labor just as they are applied to business and industrial monopolies. At the same time more vitality should be pumped into these laws all along the line.

When our basic anti-monopoly law, the Sherman Antitrust Act, was passed in 1890, it was designed to apply to economic monopolies of all kinds, and was so held by the courts. Organized labor sought exemption from this law, largely on the ground that its bargaining power was weak, as compared with that of industrial corporations. In recent decisions, a majority of the United States Supreme Court

justices have held that, when combined with the Clayton Act of 1914, the Norris-La Guardia Act of 1932 gives organized labor virtually complete exemption from the antitrust laws.

In the meantime, the relative weakness in bargaining power which was made the occasion for exempting organized labor from the antitrust laws has become a myth. In soft coal, John L. Lewis is the monopolist. Through his United Mine Workers he controls about 90% of the miners. No one of the thousand or more highly competitive companies engaged in soft coal mining controls more than about 5% of the output.

In steel the monopoly control is that of Philip Murray's United Steel Workers whose organization represents well over 80% of the production workers in that industry. United States Steel, the corporate "giant," controls only about one-third of the steel making capacity. In automobiles the United Automobile Workers represent about 90% of the production workers. A year ago the union's officers flaunted their monopoly power by announcing plans to pick off one automobile manufacturer after another by a series of centrally controlled strikes.

Industry-Wide Bargaining

Confronted by the rise of government-fostered monopoly power in the hands of organized labor, employers in some industries have sought to match it by joining together for collective bargaining on a more or less industry-wide basis. In other industries, notably steel, the federal government, through the War Labor Board, took the lead in forcing a pattern of industry-wide bargaining. Bedevilled by a myriad of cases, the Board thus sought to settle scores of them in the steel industry by one action.

It is easy to understand how an employer, confronted by an industry-wide monopoly of labor, would be tempted to join with his fellow employers in an industry-wide bargaining group. In that way he might see a chance to establish something like equality in bargaining power.

However, if the employers' bargaining group were as effective as the union in creating a monopoly set-up, it would merely confront one monopoly with another. That, in turn, would heighten the chances of having either a devastating head-on collision as a result of failure to agree, or having the two monopolies reach an agreement at the expense of the consuming public.

Actually, however, the chances that employers can create an industry-wide bargaining group as tight as that created on the side of labor by union organization are virtually zero. For if a group of employers were to agree to shut down in unison or take other united steps to balance the bargaining power created by the threat of a monopolistic union to strike, they would unquestionably find themselves on the receiving end of an indictment for violation of the federal antitrust laws.

To Break the Monopoly

Thus, both from the point of view of the public and the point of view of the employer, industry-wide bargaining is no effective offset to the monopoly power created by industry-wide unions.

The only way to cope with this monopoly power is to subject it to the anti-monopoly laws in the same way business and industrial management are subjected. In the process industry-wide labor monopolies would be cut down to safe size, possibly by limiting the percentage of workers in any industry who are permitted to belong to a single labor organization.

Also application of anti-monopoly laws would clean out local pockets of labor monopoly which block the way of industrial progress. As matters stand, the freedom of unions from control by the antitrust laws permits organized workers in one city to refuse to install equipment shipped in from another city, thus establishing private tariff walls. It also permits organized workers to refuse to install or work on materials made by other workers whose union affiliation, or lack of it, they do not like.

If the anti-monopoly laws were applied to organized labor, boycotts of this sort would be outlawed. In the aggregate they now take a tremendous toll for no legitimate purpose. But primarily John L. Lewis and a handful of his fellow labor dictators might be cut down to a size that can be safely accommodated by the American democracy. If that is not done, the last great opportunity to give industrial and political democracy a chance to work, in its last great strongbold, will be lost. From such a tragic turn of events no one would lose more than the American worker.

James H. McGraw, Jr.

President McGraw-Hill Publishing Company, Inc.

THIS IS THE 53RD OF A SERIES

Static Stability Analysis For Flying Boats and Seaplanes

PART I

By ERNEST G. STOUT, *Head of Naval Aircraft Research, Consolidated Vultee Aircraft Corp.*

The important aspects of transverse metacenter and theorem of transference, together with derivation of the expression for distance from center of buoyancy to metacenter, are detailed in this initial installment of a comprehensive series.

It is known that, if a body is submerged and displaces a weight of liquid greater than its own weight, the body will rise and float with a part of its volume above the liquid surface so that the volume submerged displaces the body's own weight of liquid; also, the resultant of hydrostatic pressures over the wetted surface of a floating body can be represented by a single force passing through the center of buoyancy (C.B.) and the center of gravity (C.G.), perpendicular to the free liquid surface. Hence, we have the following forces acting upon a floating object, such as a boat: (1) Weight of boat and all on board, acting downward through C.G. of that weight, and (2) support of water (buoyancy), acting upward through C.B. Also, for the boat to be at rest, C.G. of the boat, and all on board, must be in the same vertical line as C.B.

These principles define the statics of why and how an object will float upon a liquid, but it is obvious that a floating vessel will not always remain upright in this state of static equilibrium. It is continually under the influence of external forces, such as wind and waves, which tend to force it away from the upright. Of particular concern to the seaplane designer is the fact that the desired upright, in most cases, is not the position that the hull would normally assume under this condition of equilibrium, and a knowledge of the external forces required to maintain the desired upright is necessary. It is very important, when upright is attained, that the boat or aircraft shall have inherent qualities to insure that such inclinations which are forced upon it externally will not jeopardize its safety. Hence, these deviations from static equilibrium will be discussed, forces involved will be analyzed and calculated, and procedures detailed to insure that the static stability (tendency to return to upright) of a seaplane design will be adequate and safe.

Transverse Metacenter

To the seaplane designer, transverse inclinations are the more important, longitudinal metacenter is relatively unimportant. By definition, metacenter is the point of intersection of the vertical axis passing through the C.G. of a floating vessel and a vertical line through the C.G. of the displaced fluid (center of buoyancy—C.B.) when the body has been turned through a small angle so that the axis takes a position inclined to the vertical. This point of intersection, while simple by definition, is the controlling factor in all calculations involving the stability of floating bodies. The derivation and mechanics of this point will be covered thoroughly before proceeding to its application to specific problems.

Fig. 1 represents a section of a hull steadily inclined, at a small angle from the upright, by some external force such as wind. The boat has the same weight before and after inclination, and consequently has the same volume of displacement. We assume no weights have shifted, consequently C.G. remains in the same position. Although the total volume remains the same the shape changes, consequently the C.B. will shift from its original position. The boat is represented by the sectional view of the hull, WAL being the immersed section when upright, WL being the position of the waterline. On being inclined, $W'L'$ becomes the waterline and $W'AL'$ represents the immersed volume of the boat or hull, which, although different in shape, must have the same volume as WAL.

Since the hull retains the same volume of displacement, it follows that the wedge WSW' is equal in volume to wedge LSL'. For small inclinations, of interest to the seaplane designer, S remains on the hull centerline and is known as center of floatation. Hence, if we consider the hull inclined at a small angle from the upright (as in Fig. 1), the new volume has its center of buoyancy in a position such as B'. With B' being the new C.B., the upward force of the buoyancy must act through B' while the weight of the boat acts vertically down through G, the C.G. If the vertical through B' cuts the centerline at M, we have two equal forces acting—gravity vertically down, and buoyancy vertically up, but not on the same vertical line. Such a system of forces is called a couple. Drawing GZ perpendicular to the vertical through B', the equal forces then act at a distance GZ from each other. This distance is called the arm of the couple and the moment of the couple is $W \times GZ$.

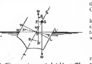


Fig. 1. Diagrammatic aspect of stable equilibrium of floating vessel.

Observation of Fig. 1 shows that the couple $W \times GZ$ tends to right the hull and is, therefore, stable. If the relative positions are such that the couple acts as in Fig. 2, the couple tends to upset the hull, resulting in an unstable condition. Again, if G and M coincide, we have a balance of forces acting in the same line with no couple, hence, neutral stability. From this we see that, for a vessel to be in stable equilibrium, the point M, which has been defined as the metacenter, must be above G, the C.G.

For all practical purposes, it has been established that point M does not change in position for inclinations up to as large as 10 or 15 deg. Therefore, we may say:

$$GZ = GM \sin\theta \tag{1}$$

If M is above G, this moment tends to right the ship, and we may say that the moment of static stability at the angle θ is

$$W \times GM \sin\theta \tag{2}$$

This is called the metacentric method of determining stability of a boat.

It is seen, from the foregoing, that the distance from the C.G. to the metacenter, GM, is the principal dimension that influences the behavior of a vessel. We shall now investigate the methods for determining this dimension for any configuration.

The position of C.G. depends solely upon the distribution of weight in the boat or aircraft and is usually available to the designer early in any design analysis. However, M depends upon the form of the underwater portion of the hull and requires special treatment.

Theorem of Transference

Before proceeding with the derivation of metacentric height, it is advisable to review a theorem of geometry upon which the derivation is based. This theorem deals with the shift of C.G. of a figure because of the shift of a portion of the latter. In Fig. 3, the area $ABCDEF$ is made up of two portions, $ABEF$ and $BCDE$, with C.G.s at g and g' respectively. Let a, a' be the areas, the whole area $a + a' = A$. Then C.G. of the whole area is at G, such that,

$$a \times gG = a' \times g'G \tag{3}$$

or

$$\frac{gG}{g'G} = \frac{a'}{a} \tag{4}$$

That is, the C.G. divides the line joining g and g' inversely as the areas. If now, area $BCDE$ is shifted to position $EFXY$ with C.G. at g'', the C.G. of the new combination $ABXY$ is on the line gg'' at G', such that,

$$\frac{gG'}{g''G'} = \frac{a'}{a} = \frac{gG}{g'G} \tag{5}$$

Therefore, by properties of triangles, GG' is parallel to $g'g''$. Also,

$$\frac{GG'}{g'g''} = \frac{gG}{gg'} \tag{6}$$

Now, taking moments about g we have,

$$a \times gg' = A \times gG \tag{7}$$

Therefore,

$$\frac{GG'}{g'g''} = \frac{a}{A} \tag{8}$$

or, the shift of GG' is,

$$GG' = \frac{a}{A} \times g'g'' \tag{9}$$

From this analysis it is seen that the whole area multiplied by its shift equals the small area multiplied by its shift, and these shifts are in parallel directions. Also, for the horizontal shift,

$$A \times gG' = a \times gg'' \tag{10}$$

and for the vertical shift,

$$A \times gG = a \times gg' \tag{11}$$

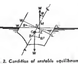


Fig. 2. Condition of unstable equilibrium of vessel.

The foregoing proof[1] is perfectly general even though a simple figure has been used for illustration, and it applies equally to a shift of weights.

To fix the position of the transverse metacenter in the hull it is necessary to know the distance BM, which is the distance from the C.B. to metacenter. If Fig. 1 represents a hull heeled over to a small angle θ, then, B is the C.B. in the upright position, B' is the C.B. in the inclined position, v is the volume of either wedge LSL' or WSW', V is the total volume of displacement, g is the C.G. of emerged wedge, g' is the C.G. of immersed wedge, and according to the theorem of transference, BB' will be parallel to gg', and,

$$BB' = \frac{v \times gg'}{V} \tag{12}$$

since the new displacement is formed by removing wedge WSW' from the original displacement and placing it in the position LSL'.

For a small angle of inclination we may say,

$$\frac{BB'}{BM} = \sin\theta \tag{13}$$

or,

$$BB' = BM \sin\theta \tag{14}$$

so that we can find BM if we can determine the value of $v \times gg'$, since V, the volume of displacement is known.

In Fig. 1, let us consider that the transverse sections of the wedges are triangles and that WW' and LL' are straight lines for all practical purposes. Now, if y is the half-breadth of the waterline at this section of the hull, we can say,

$$WW' = LL' = y \sin\theta \tag{15}$$

and the area of either triangle is,

$$\tfrac{1}{2}y \times y \sin\theta = \tfrac{1}{2}y^2 \sin\theta \tag{16}$$

Let g and g' become the C.G.s of triangles WSW' and LSL', respectively, then we can say, seeing that θ is small,

$$gg' = \frac{4}{3}y \tag{17}$$

since C.G. of a triangle is two-thirds the height from the apex.

[1] *Theoretical Naval Architecture*, page 100, Edward L. Attwood, Longmans, Green & Co., Ltd., London, 1928.

Regarding the immersed triangle as formed by the transference of triangle WSW' to LSL', the moment of transference becomes

$$(\tfrac{1}{2}y^2 \sin\theta)\,\frac{4}{3}y = \frac{2}{3}y^3 \sin\theta \tag{18}$$

and for a very small length dx of the waterline, the moment will be,

$$\frac{2}{3}y^3 \sin\theta\, dx \tag{19}$$

since the small volume is $\frac{1}{2}y^2 \sin\theta\, dx$, and the shift of its C.G. is $\frac{4}{3}y$. If we summed up all such expressions as this for the whole length of the hull we would get the moment of transference of the total wedge, or $v \times gg'$. Therefore we may say,

$$v \times gg' = \int \frac{2}{3}y^3 \sin\theta\, dx = \frac{2}{3}\sin\theta \int y^3\, dx \tag{20}$$

and we have

$$BB' = BM \sin\theta = \frac{v \times gg'}{V} = \frac{\frac{2}{3}\sin\theta \int y^3\, dx}{V} \tag{21}$$

or

$$BM = \frac{\frac{2}{3}\int y^3\, dx}{V} \tag{22}$$

But the numerator of this expression is recognized as the moment of inertia of the waterplane about its centerline, y being a semi-ordinate; therefore we can write,

$$BM = \frac{I}{V} \tag{23}$$

Since the vertical height of the center of buoyancy of a seaplane hull from the baseline is given very closely by the expression

$$CB = 65d \tag{24}$$

where d is the draft at the step perpendicular to the baseline, the transverse metacenter, M, can be located. If a more accurate determination of vertical C.B. is desired, the procedure may be obtained from any standard text on naval architecture.

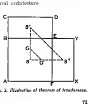


Fig. 3. Illustration of theorem of transference.

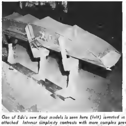
Float Structure Redesign Simplifies Output and Maintenance

Edo Aircraft's methods, applicable to many aircraft structures, result in lighter, lower-cost units.

RE-DESIGNING for production and maintenance simplification — by methods applicable to many other aircraft structures—has brought a double-edged advantage to Edo Aircraft Corp.

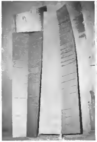
First, the new designs have brought man-hour savings of as high as 50%, resulting in economies up to $600 by purchasers. Second, weight savings of 30 lb. per float, with 35 lb additional displacement, have been made possible Beyond the added operating efficiency brought by the lighter weight is a reduction in drag through elimination of spreader bars.

How Edo engineers have cut out complex structures and difficult-to-fabricate compound curves in this new line of personal plane floats is shown in the accompanying illustrations. AVIATION photos by Bulban except where otherwise credited



One of Edo's new float models is seen here (left) inverted in jig prior to having bottom skin attached Interior simplicity contrasts with more complex previous design (right) Note that on latter, keel is part of internal structure requiring watertight joint wherever it mates with bulkheads. But new float's keel is external member joining transversely stiffened bottom skins together and obviating necessity for cutting through bulkheads

Upper skinning of new floats is done with two sheets—forward section (above) extending from bow to step, and rear section from step to stern. Each sheet is one piece from chine to chine At lower left is sample one-piece hat-shaped stiffener having single basic curve. Thus entire set of stiffeners can be made by one tool and are merely shortened to fit.



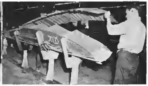
Fore and aft bottom skins (right and left respectively) are each made in two pieces Erco-riveted along center to keel. Elimination of dishing of bottom skin has resulted in but single curvature along chine. Flush riveting is used along float bottoms Another feature is that single gage skin is used throughout on new designs.

Previous type of light Edo float contained many more parts than new models Visible here, in old design, are numerous multi-piece stiffeners. Skin was also sectioned in fore and aft, top, side, and bottom components. At right alongside aft portion of float is rear top skin assembly. New floats are much more streamlined.

New compartment displays interior structural simplicity exemplified in redesigned floats. Note stamped beading in bulkhead, which formerly was braced with riveted stiffeners.

A pair of Edo's new simplified floats is seen here fitted to a Piper Super Cruiser Spreader bars have been eliminated through use of more efficient bracing system. A pair of longitudinal stiffeners atop each float also acts to provide safe footing (Ross-Pix photo)

Forward bottom skin section is here being joined to keel by means of Erco riveter. This boring versatile machine drills holes, then inserts and squeezes rivets, these operations being controlled by foot pedal. (Edo photo)



Float bottom is eased into place preparatory to riveting "L"-shaped members to which bottom skin is riveted have already been attached a chines Still to be added is streamlined nose bumper, fastened to bow by six Elastic Stop Nuts and bonded

Broad flat bottom of new float is readily apparent in this view. This feature serves to ease maintenance and repair problems by obviating necessity for use of specially formed skin sections. Decidedly fewer rivets are used in these pontoons than in older models.

Further simplification was found possible in design of hand-hole covers. New version (top) contrasts with old (bottom) in that it uses less material is lighter, and also affords easier manipulation for removal and installation.

Design of German Supersonic DM-1

By **JAMES J. RODGERS**, *Analysis Division Air Technical Intelligence, U. S Army Air Forces*

These details of the development and flight test program for the DM-1 reveal how the Reich aimed to produce a plane which could pierce the supersonic barrier while also retaining efficiency at subsonic speeds.

IN WARTIME GERMANY some scientists believed and others refused to believe that some speeds presented an insurmountable barrier to human flight The story of this conflict in thought can be extracted from technical reports now in our possession But we are primarily concerned with that little band of aeronautical engineering students who worked without pay under the leadership of Dr Alexander Lippisch, who was noted for his unorthodox designs and is now in America conferring with our Army engineers When Allied bombardment evicted the Pilots Academic Group from Darmstadt and Munich they moved to Prien Their thinking and the flight test program they developed are worthy of study.

Although it was not considered too difficult to develop an airplane suitable for supersonic speed only, it did seem very difficult to design an airplane which could fly as well in subsonic as in supersonic ranges. German developments in high speed flight research and flight testing sought a form that would meet both demands Relations of rigidity to weight, and of surface area to useful internal space, as well as the change of the flying qualities in passing the velocity of sound, would be superior to that in planes of standard construction

To be able to fly slow as well as fast, a compromise was necessary, hence planes of standard construction retained certain superiorities over the DM 1 Even standard commercial planes of today would probably be far superior to the DM-1 at subsonic speeds But at supersonic speeds the airfoil and general configuration of the former were considered impracticable because of shock wave formations, with resultant effects on stability and control.

Initially, the principle purpose was to find the necessary airplane configuration, with the development of an appropriate power plant being the next immediate consideration At that time it was believed that it would be impossible to obtain performance necessary for supersonic flight with a standard power plant and a propeller Because of compression shocks, it was uncertain whether it would be possible to obtain desired performance with a turbine power plant, although such means should be better than with a standard arrangement.

However, it was known that supersonic speed could be attained by rocket propulsion similar to the arrangement used in the Me-163 German rocket fighter (Oct 1945 AVIATION) But this type rocket propulsion was economical only in flying speeds of more than 200 kmh/ (1,250 mph).

The German development program for this project was divided into three phases, as follows

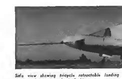
1 First model (DM-1) was to have no power plant, and it would only indicate whether the chosen configuration would cope with slow speed Plans were made to carry the DM-1 glider pick-a back style by a bomber or cargo aircraft to approximately 25,000 to 35,000 ft It would then be released for free flight to go into a dive and test high speed behavior After pulling out of this dive and nearing the ground, slow flight speeds could be investigated, including simulated stalls and sharp turns to determine what to expect for the landing condition Consideration was also given to incorporating a small rocket to test high velocity dive characteristics at speeds of approximately 500 mph

2 Second model (P-13) was to have jet power units similar to those of the Me-262 German jet fighter This model would be used to ascertain characteristics in speed ranges from 500 to 750 mph

3 Third model was to have a rocket propulsion unit (similar to Me-163) or a Lorin jet system, with which speeds of 1,215 mph were considered possible The newly developed configuration could also be used for testing other possible power to reach high speeds

The wing was a wood shell with conventional ribs, some thin stringers, a light nose spar, and a rear false spar The slotted elevons were hinged to the wings with an elliptical profile Trimming flaps were fitted in camber-flap form.

Wing configuration of DM-1 showing 60-deg sweepback of leading edge and 15-deg sweep forward at trailing edge. Ringleb profiles were used for wing and fin-rudder unit.



Side view showing tricycle retractable landing gear Retracting mechanism could be eliminated for pick-a-back flight

Design Data

Wing area	214 sq ft.
Span	19 ft., 8 in.
Aspect ratio	1 81
Profile	Elliptical, after Dr Ringleb
Ratio of thickness	0 15
Point of greatest thickness.	0 40
Root chord	20 ft., 8 in.
Mean aerodynamic chord	14 ft.
Taper ratio	18
Wing twist	0 deg.
Dihedral	8 deg
Sweepback leading edge	60 deg.
Sweep forward trailing edge	15 deg
Elevator unit area — wing area in range of ailerons	85 sq ft.
Elevator area — aileron area	23 24 sq ft.
Elevator angle	−27 deg., + 24 deg.
Aileron angle	± 21 deg.
Mean elevator chord ratio	0 27
Hinge location	0 27
Wing area in range of trim flaps	91 46 sq ft.
Trim flap area	7 21 sq ft.
Trim flap angle	±13 deg.
Mean flap ratio	0 08
Rudder unit area (fin area)	83 3 sq ft.
Rudder unit area in range of rudder (fin)	58 1 sq ft.
Rudder area	8 07 sq ft.
Span	8 56 ft.
Aspect ratio	0 82
Rudder angle	±23 deg.
Profile	Elliptical, after Dr. Ringleb
Thickness ratio	0 175
Thickness location	0 40
Sweepback leading edge	65 deg.
Sweep forward trailing edge	0 deg
Root chord	19 ft 8 in
Mean aerodynamic chord	10 ft., 5 in
Elevator chord ratio	0 14
Hinge location	0 27

Weights, Etc.

Calculated wt — empty	860 lb
Measured wt., empty (Oct 11 45)	825 lb.
Calculated total wt	880 lb.
Measured total wt (Oct. 11, 45)	1012 lb
Calculated moment of inertia	(x) 1185 8 ft.-lb.² (y) 3859 5 ft.-lb² (z) 2373 ft.-lb²
C. G location on which calculation of flying qualities is based	45% of root chord
Measured C G location (at measured total wt. = 1 012 lb)	50%
Wing loading (at measured total wt = 1 012 lb.)	4 7 lb /sq ft.
Span area loading	2 8 lb /sq ft.

Stress Analysis

Stress analysis was found according to German construction specifications (BVF) with calculated total of 880 lb under assumption of a rectangular lift and pressure distribution Safe dynamic pressure was 800 lb /sq ft., with load factor 10 and safety number 1 8

Assumed was a sinking speed on landing of 19 7 ft./sec It was also figured that there would be a ground effect For pick-a-back coupling assumed load factor was 3

Predicted Performance

Minimum speed (sea level)	44 6 mph
Minimum sinking speed	18 4 ft /sec
Best glide ratio	1 7
Terminal velocity in dive	347 mph

Fin was attached to the wing without fillets An unusually large fin width was necessary to accommodate the pilot Rudder was hinged to the fin in the same manner as elevon to wing There was no fuselage, inasmuch as all equipment necessary was incorporated in the thick wing and the fin

Tricycle landing gear could be lowered during flight However, the retracting mechanism could be omitted if only a pick-a-back takeoff were intended. Release of a knee lever catch on the gear lowered it and locked it in flight by reason of its weight Steel tubes alternately welded and put one into the other, stressed in torsion, were used in absorbing taxiing shocks. A travel of 60 cm (23 62 in) with good combination of travel and retracting kinematics was possible. The two main wheels had conventional brakes, and either wheel could be braked separately by tipping the rudder pedal. The glider, of course, did not have a power plant but was fitted with a powder rocket with a thrust of approximately 200 to 300 kg (440-660 lb)

The adjustable seat with its framework plus the undercarriage was fixed to the main ribs Transparent paneling top and bottom in the cockpit assured good visibility. To gain access, the top hood could be readily opened; for emergency exit it could be thrown off Steering mechanism consisted of a control stick and pedals which were connected to the surfaces with control rods Lateral trimming was accomplished in a conventional manner, with cable arrangement to the cambered flap

For weight trimming, a hand pump which could transfer the capacity of 35 liters (9.24 gal) of water to the front or rear tank was considered by the designers. Three fittings were installed on the underside of the glider to which a pick-a-back coupling could be attached. A normal towing arrangement could also be fitted to a special bolt on the front of the glider A pitot tube was attached to the nose of the plane for measuring undistributed static and dynamic pressure Provisions were also made for the installation of an inclinometer

Seen in this cockpit view are controls and hand pump to shift water ballast between front and rear tanks.

Flight Test Program

A Tests on Ground

1. Check of cockpit as to vision, handling, etc
2. Test of undercarriage and brakes with whole plane in towing position
3. Check of phone in pick-a-back

B Investigations During Pick-a-Back Flight

1. Stick forces at different speed and angle of yawing
2. Efficiency of control surfaces.
3. Maybe measurement of special pressure distribution over cockpit enclosure
4. Lowering of undercarriage.

C Tests During Free Flight

1. Flight qualities at normal speed with undercarriage not retracted (stick forces, efficiency of control surfaces, and also circling flight) Also same at a low speed, with special investigation of stall.
2. Same as (1) with undercarriage retracted
3. Landing qualities.
4. Test of longitudinal trim (aerodynamically and with water ballast).

D. Measurement in Free Flight

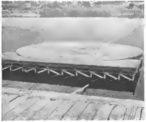
1. Performances Speed diagram, C_L-C_D—polar, gliding angles, and angles of attack
2. Longitudinal stability with varying C G. locations
3. Non symmetrical stability
4. Wool-tuft tests in low speed
5. Efficiency of control surfaces
6. Behavior in non steady motions.
7. Nose dive and maximum speed.

New Marine Turntable Ramp Boosts Seaplane Base Utility

SEEN AS AN IMPORTANT CONTRIBUTION to the development of air harbor installations, a new retractable ramp—designed by Vito Marianno and built by Seaplane Ramp, Inc.—features novel provisions for rapidly beaching and launching seaplanes, while requiring but one-man operation.

Essentially, the device is a ramp with turntable platform on an electrically operated cable car mounted on an inclined marine railway. An attendant on shore operates a push button for cable car control, and safety switches automatically stop the car at each end of the railway.

Various phases of the beaching and launching operations are shown in sequence in the accompanying illustrations depicting the installation at North American Seaplane Base, Little Ferry, N. J.



STEP 1

Beaching Operation

Step 1. Car, comprising ramp with turntable portion, is shown going down into water on inclined marine railway one track of which is seen in foreground. Car retraction cable is visible at left of track. Turntable is hinged on outward (water) side.

Step 2. When turntable has reached what would normally be water-level position, off center buoyancy tanks cause uptilt of freeboard end. Submerged end can be pointed to various directions for upwind taxiing. Craft approaches and lines up with submerged end for grounding.

Step 3. After craft (Republic Seabee) is grounded, low engine power or brakes hold it on turntable until car is drawn to shore sufficiently to bring turntable "horizontal."

Step 4. Here turntable is shown in horizontal position as retracting cable continues to draw car toward pier to complete beaching operation. At this stage, engine may be cut.

Step 5. Drawn to pier, craft may be taxied to hangar, or turntable rotated for launching operation.

STEP 2

STEP 3

STEP 4

STEP 5

STEP 1

Launching Operation

Step 1. Car begins to move down inclined railway into water.

Step 2. Here, car is submerged, turntable locked against tilting. Engine is idling, brakes locked.

Step 3. Further submergence of car brings hull to floating position so craft can taxi away. (Ellsworth Schell photos.)

STEP 2

STEP 3

Announcing The Bendix Direct Fuel Injection System!

A New Bendix-Developed fuel feed system which injects gasoline directly into each engine cylinder

Reduces fire hazard
. . . the intake passages carry air only—not an explosive mixture.

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. . . the fuel is vaporized within the engine cylinder, no "refrigeration" of intake manifold or carburetor.

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. . . leaner mixtures can be used, fuel distribution is exactly equal.

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. . . equal fuel distribution means less vibration—smoother operation.

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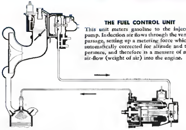
. . . a smoother operating engine means less noise and vibration.

Better altitude performance
. . . comparatively unobstructed intake passage means higher volumetric efficiency.

More engine power . . . Better engine acceleration . . .
. . . even cooling of all cylinders, requiring less cowl flap opening, thus reducing drag.

No engine stalls or faltering
. . . fuel feed not affected by gravity or inertia effects in climbs, banks or dives.

PRODUCT OF Bendix AVIATION CORPORATION



THE FUEL CONTROL UNIT
This unit meters gasoline to the injection pump. Induction air flows through the venturi passage, setting up a metering force which is automatically corrected for altitude and temperature, and therefore is a measure of mass air-flow (weight of air) into the engine.

THE DISCHARGE NOZZLE
The measured charge of fuel is sprayed into each engine cylinder through a discharge nozzle. The discharge nozzle has a spring loaded valve and spiral fuel passage to insure uniform diffusion of thoroughly atomized fuel, with a sharp, clean cut-off after each injection period.

THE INJECTION PUMP
The injection pump divides the metered quantity of fuel into exactly equal charges, one for each engine cylinder; then the pump forces one charge to each engine cylinder, timed for injection during the intake stroke.

One airline estimates that with Bendix Direct Fuel Injection their ships are saving up to six per cent on fuel. This means an increased pay load of about 900 pounds—or room for four additional passengers. Another airline expects to increase cruising speed 20 mph at high altitudes by using Bendix Direct Fuel Injection.

In addition to these remarkable advantages, it has been demonstrated that smoother engine operation and less vibration reduce maintenance costs. And of course less vibration and noise contribute importantly to passenger comfort.

An illustrated folder on the Bendix Direct Fuel Injection System will be sent upon request. Bendix Products Division, Bendix Aviation Corporation, South Bend, Ind.

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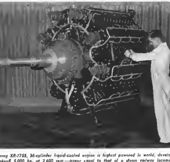
*REG U S PAT OFF

5,000-Hp. Lycoming Revealed

By J. H. CARPENTER, *Project Engineer, Lycoming Div. The Aviation Corp.*

World's most powerful reciprocating engine is liquid-cooled unit with double valve timing to enhance cruise economy.



Lycoming XR-7755, 36-cylinder liquid-cooled engine is highest powered in world, developing for takeoff 5,000 hp. at 2,600 rpm—power equal to that of a steam railway locomotive. Coolant pump has capacity of 750 gpm., oil pump circulates 71 gpm. at more than 100 psi. (AAF photo)

One of the most recent developments in the aircraft engine field is the new Lycoming 5000-hp. engine, design of which was initiated in 1943 through negotiations with the AAF Air Materiel Command. This power plant is now on test at the factory.

Throughout design, emphasis was placed not only on simplicity for flight weight and for ease of maintenance, but principally on minimum fuel consumption. The displacement is large to obtain the advantages of high compression ratio and low boost.

This new engine, known as Model XR-7755, is a liquid cooled 36-cylinder radial type, consisting of four rows of 9 radial cylinders. Fore and aft, the cylinders lie in nine 4-cylinder banks. It is 6⅜ in. bore by 6¾ stroke with a total displacement of 7,755 cu. in. Though designed for cylinder fuel injection, carburetor or spinner injection can be used if desired. Overall diameter is 61 in., and overall length is 122 in. including 60L-80 dual rotation propeller shafts. Magnetos, distributors, starters, tachometers, and fuel injector governor are mounted on the front of the engine, all other required AN drives are provided at the rear, including the fuel injector drives, all of which are easily accessible.

The crankshaft has four crankpins, each 180 deg. from the adjacent crankpin. This shaft is of split design to permit use of a solid master rod, and it consists of five sections joined together at the rear of each crankpin through a Gleason curvic tooth clutch, or face spline, and the sections are held together by four axial bolts at each crankpin. Four small bolts are used in lieu of one large bolt to facilitate tightening, which does not require any special fixtures. Assembly bolt stretch is measured by means of a dial indicator at the head of the bolt. Two dynamic-vibration type dampers are mounted on the front and rear cheeks, 180 deg. apart. Secondary balance weights are mounted on the front and rear of the shaft. The shaft is mounted in the crankcase on five roller bearings, the three intermediate bearing inner races having spherical seats on the journals.

Crankcase is of forged steel fully machined, and it comprises five sections, these being held together by nine bolts extending the length of the case.

The four master connecting rods incorporate the semi-floating crankpin bearing and end seals, through which lubrication is provided to the link pins. The end seal plates also act as link pin retainers and permit only a slight rotational movement of the link pins to promote lubrication in the master rod. Complete master rod, link rod, and end seal assembly and disassembly can be accomplished without tools or fixtures. Link rods are of conventional design.

Pistons are of forged aluminum, with four rings all above the piston pin. The top ring is flat-face chrome-plated cast iron; second and third rings taper face, plain cast iron, all Keystone type; and the bottom a conventional oil control ring. The cylinders are of individual construction, with nitrided barrel and spun steel coolant jacket sweated together.

Cylinder heads are cast four-in-line complete with coolant jackets, cam drive housing, and bases on which are mounted camshaft and rocker shaft bearing pedestals. The combustion joint between head and barrel is through a metallic compression seal. A synthetic rubber ring provides a coolant transfer joint from head to barrel. Individual barrels are therefore very easily replaceable, no special tools or fixtures being required.

One intake and one exhaust valve per cylinder are used, the exhaust having internally cooled stem and head, the intake having internally cooled stem only.

The camshaft is driven through spur and Zerol bevel gears from the front of the crankshaft. A spur and bevel gear train at the drive end of the camshaft provides a 1⅛-ratio drive for the two magnetos, and half-speed drive for the four distributors and two tachometers. The shaft is designed for two different valve timings and carries two lobes for each valve, one for cruise economy, the other for takeoff power. When shifting from one set of cams to the other, a change in spark timing is also effected at the distributors.

The supercharger is centrifugal, with a radial diffuser between impeller and outlet scroll housing, from which nine tangential outlets transfer the charge to the nine intake manifolds. All required AN accessory drives, including fuel injector drives, are provided in this section, except starters and tachometer, which are mounted at the front of the engine.

From each of the supercharger outlets the charge is taken into a 4-cylinder manifold. These manifolds incorporate large area backfire screens, and they are mounted in the center of the V between cylinder banks.

Dual rotation propeller reduction gear is a planetary system providing two propeller drive speed ratios which can be shifted in flight. Shifting is accomplished hydraulically, and provides a positive drive to the propellers without the use of friction clutches. The unit includes a hydraulic torque meter.

The ignition system is of low tension type in which low voltage current is supplied by the magnetos, through the distributor to the transformer coils mounted directly on each sparkplug. This system permits small ignition harness shrouds and provides better radio shielding. Location of all sparkplugs permits ample space for removal, and plugs are accessible from any radial position around the engine.

An aluminum mount housing is incorporated with the supercharger scroll housing on which pads are provided for attaching flexible mounts of the dynafocal type.

Exhaustive single-cylinder tests involving over 10,000 hr. of operation have been underway for the past two years. Of this time nearly 7,000 hr. have been expended on cylinders and pistons identical with those used on the multi-cylinder engine. Tests are still in progress to improve performance and endurance characteristics, with every effort being placed on minimum fuel consumption.

A rig for testing the two-speed shift mechanism of the reduction gear has completed over 600 shifts satisfactorily, simulating actual engine conditions.

The crankshaft has passed several 10,000,000-cycle fatigue tests at various loadings on a special machine which subjects the shaft to bending, torsion, and vibratory loads, simulating those imposed in the engine. Fatigue tests have been conducted on the piston, piston pin, link rod, and link pin in a G.M. fatigue machine. Every part has satisfactorily passed all requirements.

A special machine was built to fatigue-test the master connecting rod section around the link pin, and to develop the crankpin bearing and link pin lubrication. This has resulted in completely satisfactory parts. Many other tests have been conducted on various components of the engine, such as the oil pressure pump, oil scavenge pump, and coolant pump. A special rig to test the supercharger section has been highly successful in determining supercharger characteristics, and considerable development work has been completed.

Facilities are available and tests are now underway to subject to stress coat and strain gage analysis all major parts.

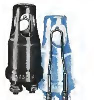
A nose-to-nose test, using two complete reduction gear units coupled together through the propeller shafts, statically loaded and dynamometer driven, will be run at an early date to develop the unit under full torque conditions.

The new experimental laboratory offers many test facilities not formerly available at Lycoming. It is now possible to conduct endurance and performance testing on practically any engine component, either as an operating unit or as an individual part. Tests have been, and are being, conducted on as many of the components as is practical, and the results obtained have proven their value to an overall program, both in factors of time and of expense.

Specifications and Data

Normal rated power	4000 hp. at 2300 rpm.
Takeoff power	5000 hp. at 2600 rpm.
Number of cylinders	36
Bore	6.375 in.
Stroke	6.750 in.
Cylinder arrangement	4 row radial
Displacement	7755 cu. in.
Coolant medium	Liquid
Supercharger	single speed-single stage
Impeller dia.	14.4 in.
Impeller ratio	8.0:1
Fuel	grade 130
Engine fuel feed	Equipped for either carburetion or fuel injection
Ignition	2 Bendix DRN-7, low tension magnetos
Propeller drive	
2-speed gear reduction	high, .2460; low, .3536
Dual rotation propeller shaft	Inboard counterclockwise; outboard clockwise
Propeller shaft spline	60L-80
Length	121.35 in.
Width	60.50 in.
Height	66.25 in.
Diameter	61.00 in.
Total dry weight	6050 lb.

Nothing's much simpler...



... than a piece of wire

This thermocouple detector is the heart of the Edison Fire Detection System. It's just a piece of wire.

The fire-sensing portion of the Edison System consists only of these detectors connected in series and mounted where needed in the area to be protected.

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The rugged simplicity of the Edison Fire Detection System is the reason it has been adopted on hundreds of today's transport planes.

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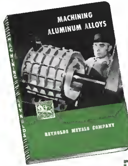
SPECIFIC RECOMMENDATIONS FOR MACHINING OPERATIONS IN COMPACT CHART FORM



There are a lot of practical, up-to date facts about machining aluminum alloys packed into this new 124-page handbook compiled by the technical staff of Reynolds Metals Co.

For instance, eight double-page charts give specific usable data on tooling, speeds and feeds for eight important types of machining operations: Turning, milling, shaping and planing, drilling, reaming, tapping, filing and sawing.

In addition there are detailed discussions on general machining characteristics of the various aluminum alloys, with chapters on machining conditions, tool materials and designs, cuts, speeds and feeds, lubricants, coolants and cutting compounds.

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PRACTICAL ENGINEERING OF ROTARY WING AIRCRAFT

PART VI

By JOHN E. McDONALD, Engineering Staff, Autogiro Company of America

Continuing his embracing analysis of vibratory phenomena in rotorcraft, Author McDonald presents important details of axial motion of a rotor, blade motion about vertical hinge, and effective inertia of rotor in torsion.

A QUESTION OFTEN ARISES concerning the natural frequency in the axial direction of an elastically mounted rotor. One specific case is the problem of a torque correcting rotor mounted on a flexible boom. It is most convenient to calculate the "effective mass" of the rotor blades at various rotative speeds and to employ this value in the determination of natural frequencies. The problem is treated in its idealized form, the assumptions being made that blades are hinged at the axis of rotation, also that aerodynamic forces are non-existent.

In Fig. 5, x denotes axial displacement of rotor hub from its mean position, under the action of the oscillating force F.

It is expedient, in this problem, to employ La Grange's equations of motion in the customary form

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}}\right) - \frac{\partial T}{\partial q} + \frac{\partial V}{\partial q} = F \qquad (8)$$

where T is kinetic energy of the system, V, potential energy of the system, q generalized coordinate; and F, generalized force associated with q.

Value T becomes

$$T = n\left[\tfrac{1}{2} m (\dot{x} + b\dot{\beta})^2 + \tfrac{1}{2} m\rho^2\dot{\beta}^2 + \tfrac{1}{2} m \Omega^2 \cos^2\beta\,(b^2 + \rho^2)\right]$$

Potential energy $V = 0$, and the generalized force $F = F_o e^{i\omega t}$.

Substitution into La Grange's equations yields

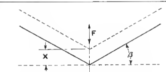


Fig. 5. Schematic diagram of axial motion impressed on rotor.

$$nm\ddot{x} + nmb\ddot{\beta} = F \qquad (9)$$

$$nmb\ddot{x} + nm\,(b^2 + \rho^2)\ddot{\beta} + nm\Omega^2\,(b^2 + \rho^2)\,\beta = 0 \qquad (9a)$$

If solutions are assumed and substituted in the form

$$x = x_0 e^{i\omega t}$$
$$\beta = \beta_0 e^{i\omega t}$$

then, simultaneous solution of the foregoing equations for x_o gives

$$x_o = \frac{F_o}{-\omega^2\left[nm\left(1 + \frac{1}{(1 + \rho^2/b^2)\,(\Omega^2/\omega^2 - 1)}\right)\right]} \qquad (10)$$

It will be apparent that the bracketed expression in Eq. (10) has the dimensions and influence of an inertia. It represents, in fact, the virtual mass of a rotor subjected to an axial shaking force of amplitude F_o and frequency ω. Depending upon the value of the ratio Ω/ω, virtual mass may range between the limits of infinity and a magnitude less than actual total blade mass nm. When the term Ω/ω equals unity, the virtual mass becomes infinite and the displacement x_o becomes zero. In this case, rotative speed, shaking frequency, and natural blade flapping frequency all coincide, and the blades actually perform the function of a dynamic absorber. In the idealized case treated here in the absence of damping the blade amplitude β_o would become infinite.

At high values of Ω/ω (low order shaking-frequencies), the rotor acts as a rigid body evidencing a virtual inertia equal to the blade mass nm.

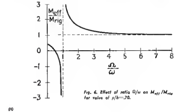


Fig. 6. Effect of ratio Ω/ω on M_{eff}/M_{rig} for value of $\rho/b = .70$.

Ratio of virtual inertia to total blade inertia (rotor considered as a rigid mass) may be written

$$\frac{M_{eff}}{M_{rig}} = 1 + \frac{1}{(1 + \rho^2/b^2)\,(\Omega^2/\omega^2 - 1)} \qquad (11)$$

This ratio is plotted in Fig. 6 for a typical rotor where $\rho/b = .70$.

Blade Motion About Vertical Hinge

If aerodynamic forces are neglected, a hinged blade is in equilibrium under the combined influence of root spring and centrifugal restoring moments and inertia moments as shown in Fig. 7.

The equilibrium equation becomes

$$\ddot{\gamma}\int_2^R r^2 dm + \gamma\int_2^R \Omega^2\frac{(a + r)ar}{(a + r)}\,dm + \gamma\, K\gamma = 0 \qquad (12)$$

In the foregoing, $K\gamma$ is the angular spring rate of a root restoring spring as often employed,

but $\sqrt{K\gamma/m(b^2 + \rho^2)} = \omega_{\gamma 0}$, the natural frequency of the blade under the influence of the root spring alone. Therefore, in the usual form the equation yields

$$\frac{\omega_\gamma}{\Omega} = \sqrt{\frac{ab}{b^2 + \rho^2} + \left(\frac{\omega_{\gamma 0}}{\Omega}\right)^2} \qquad (13)$$

If no spring restraint exists,

$$\frac{\omega_\gamma}{\Omega} = \sqrt{\frac{a/b}{1 + \rho^2/b^2}} \qquad (13a)$$

In a typical design possessing characteristics $\rho/b = .70$, $a/b = .075$, the pendular frequency ratio becomes

$$\omega_\gamma/\Omega = \sqrt{.075/1 + .49} = .225$$

Fig. 7. Forces acting on rotor blade when displaced about drag hinge.

Effective Inertia of Rotor in Torsion

Under the action of a forcing torsional couple, a rotor consisting of a hub and freely pinned blades will evidence an effective moment of inertia which varies over wide limits depending upon the frequency of the forcing function. A useful value of this effective inertia will be developed for the ideal case when no root spring restraint is utilized.

In Fig. 8, θ is angular displacement of hub about its mean position measured relative to a rotating reference frame, γ is angular displacement of blade measured from its mean position, and Q is oscillating torque applied to hub, assumed to be of the form $Q_o e^{i\omega t}$ where ω is the forcing frequency.

Kinetic energy relative to a coordinate system rotating at speed Ω is written directly

$$T = \tfrac{1}{2}\left[nm\rho^2\,(\dot{\theta} + \dot{\gamma})^2 + nm\,(\dot{\theta}\,(a + b) + \dot{\gamma}b)^2\right]$$

Potential energy in the rotating system results from shortening of radius to the blade mass center as the blades oscillate. Its magnitude equals the product of the total centrifugal force and the amount of foreshortening of the radial distance to the blade C.G.

$$V = \tfrac{1}{2}\,nm\Omega^2 ab\gamma^2$$

Employing La Grange's equations in a similar fashion to that utilized earlier,

$$\ddot{\theta}nm\,[\rho^2 + (a + b)^2] + \ddot{\gamma}nm\,[\rho^2 + b\,(a + b)] = Q \qquad (14)$$

$$\ddot{\theta}nm\,[\rho^2 + b\,(a + b)] + \ddot{\gamma}nm\,(\rho^2 + b^2) + \gamma nm\Omega^2 ab = 0 \qquad (14a)$$

Substituting $Q = Q_o e^{i\omega t}$, $\theta = \theta_o e^{i\omega t}$, and $\gamma = \gamma_o e^{i\omega t}$ in Eqs. 14 and 14a, simultaneous solution for θ_o yields

$\theta_o = Q_o \div$ the denominator

$$-\omega^2\left[nm\left(\rho^2 + (a + b)^2 - \frac{(\rho^2 + b^2 + ab)^2}{\rho^2 + b^2 - \left(\frac{\Omega}{\omega}\right)^2 ab}\right)\right] \qquad (15)$$

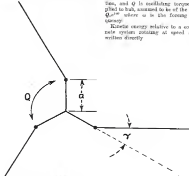


Fig. 8. Blade displacements about drag hinges on three-blade rotor.

The bracketed expression in the denominator is the effective moment of inertia of the rotor. Its magnitude is obviously influenced to a major degree by the "order" of the forcing frequency as reflected in the factor Ω/ω.

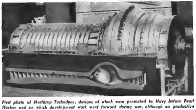
Since the moment of inertia of a rigid rotor with blades frozen on their hinges is $nm\,[\rho^2 + (a+b)^2]$, it will be convenient to express the effective inertia as a ratio to the rigid inertia. This ratio becomes

$$\frac{I_{eff}}{I_{rig}} = 1 - \frac{\left(1 + \frac{ab}{\rho^2 + b^2}\right)^2}{\left(1 + \frac{a\,(a + 2b)}{\rho^2 + b^2}\right)\left(1 - \left(\frac{\Omega}{\omega}\right)^2\frac{ab}{\rho^2 + b^2}\right)} \qquad (16)$$

National Aircraft Show Hits Highs in Size, Attendance

Opinion divided on ultimate value of $1,000,000 exhibit, which revealed new craft and installations—a 'copter, cargo carrier, power plant, and special control system. Personal planes, military services get major attention.

Announced during First National Aircraft show was Curtiss CW-32 four-engine cargo plane now in engineering stages. With 25,000-lb payload for 1,500 mi range, craft will have gross weight of 80,000 lb. and cruising speed of 270 mph at 25,000 ft. Designed for basic crew of two, CW-32 will have pressurized cockpit. Three large cargo doors give access through fuselage sides, smaller door in nose will accommodate hand-packages. Optional arrangement permits empennage to swing up over fuselage for taking on large loads such as automobiles.



First photo of Northrop Turbodyne, designs of which were presented to Navy before Pearl Harbor and on which development work went forward during war, although no production contract was awarded. Cutaway section shows 17-stage axial flow compressor, short annular combustion chamber, and 3-stage turbine. Unit was designed to develop equivalent of 2,400 hp. at 10,000 rpm at 18,000 ft. with 1,450-deg combustion chamber temperature. (Martin & Kelman photo)

THE ONE WORD "BIG" is the best single adjective to apply to the nation's first postwar National Aircraft Show, held in the huge wartime bomber plant at Cleveland Airport from the 15th through the 24th of last month.

First, it was the biggest show in the industry's history from the standpoint of participation, with more than 155 exhibitors, including aircraft manufacturers, engine and accessory producers, component manufacturers, affiliated industry representatives, and the military services.

Second, it attracted the largest audience to ever view an indoor aircraft display, the final total topping 150,000 paid admissions. The 47,500 paid admissions reached the first Sunday—competing with a professional football game drawing over 60,000—set a record never before reached.

And, third, the actual floor space—some 500,000 sq. ft.—was the largest ever devoted to an aeronautical display. This very roominess brought some early illusions of poor attendance, for with anything less than 5,000 to 6,000 visitors, the vast display section looked quite deserted.

Helicopter and personal plane displays, with excellent locations adjacent to the broad main entrance ramp, were among the best attended throughout the 10-day show.

Rotary wing displays included those of Bell, with three models, Firestone with one, and Sikorsky with two, including a surprise entry, the new S-52. This is a two-place craft powered by a 178-hp. Franklin engine giving a 105-mph. top speed, 90 mph. cruising speed, 1,500-fpm. climb at 40 mph., and service ceiling of 16,000 ft.

It features all-metal blades—the first specified as standard equipment. These consist of extruded leading edges to which are riveted trailing edge sections of approximately 6-in. length. The trailing edge sections can be replaced if damaged, and the leading edge can be treated the same as a propeller for repairing minor damage. Sikorsky engineers report that the blades have been designed for "life of the ship" service, with replacements necessary only in case of accidental damage. Production costs of the new type blades, it was reported, will be well below costs of earlier spar-and-rib types.

Though design and construction details have not been made available, it was noted that the hub construction differs considerably from other Sikorsky types. One principal difference lies in the fact that the flap and drag hinges are concentric with the plate-type hub.

Fuselage and anti-torque rotor booms are semi-monocoque construction designed to lower costs. Though no price was quoted, it is said the final figure will be well below current rotary wing craft costs.

Personal planes on display included: Aeronca Chum and Chief; Beech Bonanza and 18S; Bellanca Cruisair, Cessna 120 and 140; Ercoupe; Luscombe Silvair; North American Navion; Piper J-3 and J-5; Republic Seabee; and Stinson Voyager 150.

Exhibitors reported both quality and quantities of questions and inquiries were good, and they were pleased to note that women were taking more than a passing interest in cabin arrangements and furnishings. Demonstration flights were made throughout the show by local distributors, but no reports as to resulting sales were available at show closing time.

Personal plane flying was given something of a permanent boost during the show when a downtown lakefront flightstrip was opened by Cleveland's Mayor. Although still in crude shape, the strip was well utilized for shuttle service during the show. An AVIATION correspondent, making the first flight in a North American Navion with Test Pilot Bob Chilton, went from the strip to the show entrance in 7½ min.—compared with an average of 45 min. for surface transportation to the exposition.

Pressing the personal planes and helicopters for attention were the military services' large exhibits, with Navy appearing to have a definite edge because of the large number of "audience participation" features. Many of these were units from the Special Devices Division used for training or development purposes, and they were constantly in use, especially by the "small fry" who were adept at getting in ahead of elders who would have liked a try at the operations.

First shown publicly at Aircraft Show—new 165-hp. liquid cooled Jacobs 0-360L six-cylinder opposed engine designed for use in aircraft, automobile, or marine installations. (Martin & Kelman photo)

Perhaps the most interesting engineering feature of the Navy exhibit was the standardized cockpit, developed jointly with the AAF and RAF, and designed into an aircraft for the first time in the Fairchild XNQ-1, which was on display.

In this development all control units will be located in the same position regardless of the make of plane, with size and shape of controls varied "psychologically" for quick and positive identification. A landing gear actuating switch, for example, has a knob looking like a tire; an arrester hook switch is hook shaped.

That engineers are still at work on airplane control systems was evidenced by the first public showing of the Beetle Tri-Control, a system which eliminates rudder pedals but still maintains the conventional three-control features. The control wheel moves fore and aft for elevator control as usual, turns on its axis for aileron control, and is moved to right or left for rudder control.

Walter Beetle, its inventor, has installed a unit in a Taylorcraft, which was CAA certified with it, and during the show he granted a license for the control system's manufacture by North American. Two other manufacturers were also reported interested in license agreements.

Reactions of parts and accessory manufacturers as to the ultimate value of the show were varied. Many of those producing consumer goods, especially in the personal plane field, reported that inquiries were excellent and that good prospect lists had been built up.

However, others whose products are sold to manufacturers rather than direct to ultimate consumers, and those whose products don't lend themselves to audience participation displays, believed they could have accomplished as much or more with smaller "suitcase shows" put on at meetings confined to the industry itself. And in event a public exhibit had to be held, they also generally agreed that they could have achieved as good or better results with small, less expensive displays which could have been moved to several smaller shows.

In virtually every case manufacturers mentioned the matter of expenses, not only the actual costs of space and exhibit materials, but of the manpower required to staff a booth for 12 hr. a day for 10 days. Not only was this particularly true of the smaller producers perennially hard pressed for adequate manpower, but it also came in for discussion among the larger organizations which are accustomed to good sized budgets for exhibits.

It is estimated that altogether the industry invested between $1,000,000 and $1,500,000 in the show exclusive of the cost of the products which were put on display.

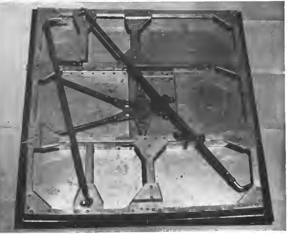
Surprise entry at National Aircraft Show was Sikorsky S-52 new two-place helicopter featuring first standard-equipment all-metal rotor blades. With useful load of 650 lb. and range up to 310 mi. craft is designed for both military liaison and patrol work, as well as civilian uses. Powered by 178 hp. Franklin, it has top speed of 105 mph., cruising speed of 90 mph.

Integral Stiffening Saves Time, Parts, and Tools

Stiffening features, formed into a radio access door as an integral part of a Glenn L Martin design, eliminated many small riveted clips, gussets, ribs, and other details.

Door consisted, basically, of two parts—flat outer sheet and stiffened inner sheet formed by drop hammer—joined by spotwelding.

Stiffening by this method, which requires forming dies, was not feasible on prototype design because of small quantity required and lack of time. However, the contrast between the two doors, shown in the accompanying illustrations, depicts how stiffness in sheet metal parts can be achieved simply and efficiently.



Prototype door with opening mechanism. Note many small riveted gussets, ribs, and other details

Improved design, incorporating stiffening sheet spotwelded to flat sheet. Mechanism is assembled in much the same manner, with locking rods passing through holes in stiffening formations.

If the change had not been made, many tedious shop operations would be required to produce the details—shearing, blanking, routing, burring, hydropress forming, drilling, and riveting. Also, numerous tools would be required—blanking dies, router boards, forming dies, drill templates, and jigs.

Assembly of this complex design is slow because of the many details involved and difficulties caused by accumulation of manufacturing tolerances. And numerous parts required bring procurement delays and necessitate excessive stock storing and handling.

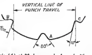
Tools used in development of the new type door consisted of two sets of drop hammer dies, each made up of an upper and a lower unit. Two forming operations are required because of the arrangement and depth of the stiffening elements.

Built-up prototype door and the formed unit, both made of aluminum alloy, weighed approximately the same. But it was found that the forming method provided stiffness beyond design requirements, hence, with stiffness to spare, gages could be reduced substantially with a resultant saving in weight. This extra stiffness allowed even further weight savings, since it was found that doors of sufficient strength could be made of magnesium sheet.

In each case, depth and amount of draw and pattern need will depend upon individual design requirements. Suggested hints in application of integral stiffening include:

1. Small blank size will form into deeper draw than larger size blank because amount of necessary shrinkage is proportionate to increase in blank size.

2. Heavier gages form more readily than lighter gages. As thickness decreases, forming difficulties increase.



Angle (A) at 80 deg. may be formed without difficulty because there is no interference with punch, while angle (B) is also 80 deg. but does interfere. Angle (C) indicates correct design procedure.

Thin metal is less stable in compression; hence, more wrinkling occurs.

3 Included angles of 80 deg. between the walls of stiffening elements are acceptable, provided basic contour of part does not cause either side of stiffening formation to be at less than 10 deg. to vertical direction of punch travel.

Transport-Cost Precision Via P-S-D Approach

By A CANADIAN BUSH PILOT

Finding it impossible to get true analyses of aircraft economics with "job lot" per hour, per mile, and per-ton-mile measures, the author details how power-space-density denominators may be adopted to obtain efficient—and more profitable—operations accounting.

Without going into the background of present day fares and rates for air transportation, it is proposed to present a new approach to the problem of economic analysis of aircraft operations. Limitations and inflexibilities of per-hour, per-mile, and per-ton-mile rate gives ample reason for such consideration.

Take rate per hour and rate per mile. There is little in them by which the efficiency of the aircraft or operation may be judged. Neither can either term be precisely and logically related to the other because there is a fundamental difference in their conception. The rate *per hour* cost is constant, no matter in what direction the aircraft is flying; it involves no ground reference, it would still remain unchanged if the aircraft were operated constantly around a 5-mi. closed circuit. The rate *per mile* cost varies constantly depending upon the behavior of the air stream in which the aircraft is supported. In the case of a rate *per ton-mile*, such a figure can only apply logically when the aircraft is carrying a payload of constant density throughout.

Density Makes Big Difference

No economist would seriously support the contention that it costs the same per ton-mile to move 2,000 lb. of passengers in 500 cu. ft. of luxurious cabin space as it does to move 2,000 lb. of freight in 200 cu. ft. of cargo compartment. Ton-mile rates have been used with inconsistent and unrealistic results. These results cannot be otherwise, since fares refer to space, while express rates refer to weight primarily, and there is a wide variance in the space required for each type of payload on the same aircraft. Having disregarded the fundamental consideration of density, the ton-mile rate has no magic in it that will mysteriously bring fares and rates into parity.

The importance of density is brought home in realistic and inescapable fashion to the bush flyer, sans theory or assumptions, when he finds that it requires two aircraft to move a ton of beds and mattresses to a mining camp, while he requires only one of the same type of aircraft to move a ton of mineral concentrates out from the mine to the railhead. Accordingly, one is given to think furiously on the necessity for packing as many pound-miles into a cubic-foot-mile as possible—and on all occasions—in order to remain solvent.

From this constant struggle for survival there arose a need for more precise economic tools for measuring both accomplishment and trends. In addition to the cubic-foot-mile and the density loading per cubic foot, it seemed desirable to find a consistent unit for measuring expense in equal increments. The average cost per cruising horsepower-hour seemed to meet this requirement.

Measure for P-S-D

A new approach to aircraft operation economics, fares, and rates is possible through the use of the following power, space, and density units:

Cost per cruising hp.-hr.
Cost per cu. ft.-mi.
Density loading per cu. ft.

Cost per cruising hp.-hr. falls into two general divisions. The first division includes only those items which can be classed as mechanical airborne costs. These items are those which accrue as the aircraft flies. On the assumption that if a fleet of aircraft is owned it must be worked, depreciation can be classified as an airborne expense. Depending upon company policy, the rate of depreciation should be as high as income will permit, since obsolescence is a constant and uncertain pressure on the operator to modernize his fleet to meet competition. Current rates and fares are such that the operator cannot retire new aircraft much sooner than 5 yr. from purchase. The structure of modern aircraft, of course, permits a much longer operational life than financial life.

The fares and rates have an overpowering influence on utilization. It can be said that utilization is fixed within narrow limits when the fares, rates, and costs of the aircraft are established. On the highly competitive routes in the United States, a minimum utilization of 10 hr. per day per aircraft seems imperative. Thus, the financial life, or retirement period, for the large, modern aircraft may be taken, conservatively, to represent 5 yr. of 3,650 hr. each, or a total of 18,350 hr. By the fact of the necessity of performing 18,350 flying hours within 5 yr., the following airframe costs may be classified as "mechanical airborne costs" by virtue of their enforced regularity:

Depreciation—aircraft less power
Overhaul—cost of material
Overhaul—cost of labor, direct, productive
Aircraft servicing—cost of material
Aircraft servicing—cost of labor, direct, productive

In the above classification of direct airframe costs, the labor costs, it will be noted, are confined to direct productive labor which is related to the intensity with which the aircraft is operated. The material and labor cost per cruising hp.-hr. can be taken directly from experience statistics of a similar operation, preferably using aircraft of smaller cruising power.

Failing experience figures, the total cost for material and direct labor would have to be budgeted in the ordinary way for the whole life of the aircraft, or 5-yr. operation period, and then reduced to a cost per hp.-hr. by dividing the total budgeted amount by the total hp.-hr. to be used for the period—the amount of the budget being controlled, of course, by maintenance policy setting the relationship between the annual charges for overhaul and the original cost of the aircraft less power.

The second division of mechanical airborne costs concerns power as a separate consideration. In order to arrive at the unit cost for power plant depreciation it is necessary to assume a financial life for the engine. This is usually set at 7,000 hr. flying time. Assuming we have a million dollar airframe with four engines installed delivering a combined cruising horsepower of 5,000 for 18,350 hr. of life of the airframe, the number of engines to be utilized can be found as follows:

Total cruising hp.-hr. for life of airframe *divided by*
Cruising hp.-hr. for life of one engine

Since the cruising horsepower of one engine is one quarter of 5,000, the

above computation works out to 10 48 engines If the engines cost $40,000 each, we can easily find the depreciation rate per hp -hr. for the complete power investment

The cost per hp -hr for specific fuel and oil consumption is easily obtained from the engine manufacturer's specifications and the known price of fuel and oil per gallon or per pound.

The cost per hp -hr. for engine overhaul material and labor may, as in the case of the airframe, be taken directly from similar experience figures of other major operations.

It has been found that the above-mentioned expenses are all that can be readily included in the category of mechanical airborne costs. It will be found that for operations of the order of, say, 10,000,000 mi per year and up, using aircraft of 1,200 cruising horsepower and up, the mechanical airborne costs per hp -hr. should be fairly constant and similar within narrow margins. The results should be sufficiently close to make efficiency comparisons between different types of aircraft, or between the same type of aircraft with different types of power.

Translation to Rates

Next problem is to translate the whole mechanical airborne cost into terms of fares and rates If, for example, the mechanical airborne expense works out to 5c per hp -hr , what portion is this of, say, the fare of 5c per passenger-mile? In order to translate the cost unit as a portion of price, an intermediate unit is needed to bridge the gap The cubic-foot-mile fulfills this requirement

It will be readily admitted that the cost to move each cubic-foot of payload is the same Thus if an aircraft expends 5,000 hp-hr at 5c. each to move 5,700 cu ft. a distance of 300 mi., then the cost per cubic-foot mile evidently is $0.000146 If the passenger uses 80 cu ft of space for himself and baggage, then the mechanical airborne cost will amount to $0 01168 The remainder of the 5c. per passenger-mile, $0 03832, must cover all other company operation expenses and, say, 10% for profit The $0 005 profit deducted from $0 03832 leaves $0.03332 out of the price of 5c per passenger-mile, which is the "permissible" expense for all charges not covered by mechanical airborne cost

In like manner the relationship between the mechanical airborne cost and the rate per pound mile for cargo can be established, depending on the average number of pounds per cubic foot the cargo compartment will accommodate.

By establishing the above relationship, the permissible unit cost per hp.-hr. is determined, which fixes the limit of general company expense without encroaching upon profit If company expense cannot be confined within the permissible limits, the computation at least provides a datum line showing the expense in this category that is justified by the aircraft, rate, and route. There will be less mystery as to why there are few profits in current air transport operations

To sum up the foregoing discussion, it can be said that price, be it fare or rate, is broken down into three sections, namely:

Mechanical airborne costs
Permissible general company expense
Profit

It is evident, from the study of the economic analysis of various aircraft operations that price has a dictatorial influence on utilization If it be accepted that few operators can afford to own idle aircraft, decisions about utilization cannot be avoided. Through this method of approach to the problem of economics of aircraft operation it is realized that the choice regarding utilization is limited to a very narrow margin—assuming, of course, that the operator is striving to run a normal business enterprise with profit as his object Once the aircraft is bought and normal establishment is created to support it, the price in the form of an approved fare or rate fixes the permissible expense for indirect or supporting costs, including flight crew. This, in turn, determines utilization, in that sufficient hp-hr have to be used to build up a fund equal to the annual requirement for indirect charges

It is necessary to hold the direct or mechanical airborne charges to a definite and carefully selected group of expenses so that the aggregate of the group represents a reliable value for comparing different types of aircraft This is not to say that aircraft efficiency cannot be adequately compared on the engineering level, and without the use of the dollar sign, but the comparison of mechanical airborne costs does provide additional and revealing light

The permissible expense becomes a reliable control on the extent and type of organization that can be had for any given aircraft or fleet. That is, the permissible expense rules the type of company organization By this system of analysis, through the use of costs based on power, space, and density units, it is possible to determine the costs and prices justified by the aircraft employed Prices other than those indicated, which include normal business profit, can later be arrived at for any reason of policy that seems justified at the time These latter prices, however, seldom have a close relation to the cost of operation

Special prices, which may be classed generally as promotional, competitive, social, or diplomatic, do not necessarily have the cost of operation as an essential part of their structure. This fact does not eliminate the business practice of knowing the cost of the goods one has for sale before variants are approved, otherwise it is difficult to know who is subsidizing what

Use of the Work Table

For purposes of demonstrating the power-space-density method of approach, let us assume we are examining a hypothetical postwar transport airplane—hypothetical in order to broaden our example and to avoid "vivisection" of any specific type ship. Now, under three heads—Original Data, General Equations, and Mechanical Airborne Cost Per Hp-Hr —we compile a list of 53 specifications Presented in the Work Table accompanying this article, these specifications give the pertinent basic data which will serve us in our calculations

There is some middle ground between the extremes of 29c and 17c per hp -hr dictated by potential traffic, which is more likely to reflect what will be the actual experience when using the aircraft under investigation Not many companies would choose to make heavy investments in aircraft of a large type if only 50% payload could be counted on for the life of the aircraft But, if the cost per hp -hr. can be kept down to the lower figure, then extra profit will result from all loads in excess of 50% of the aircraft capacity. In any case a company "indirect" expense datum line has been defined as a working factor

The foregoing analysis is a method of approach to the problem of adjusting the aircraft and its supporting company organization to pre-set conditions where fares and rates have already been fixed by government approval.

Another approach is through the use of experience statistics for the permissible indirect expense, which figure added to the mechanical airborne cost provides a total cost per hp -hr. To this total is added the required profit, and then the fares and rates at which the aircraft will work are determined as in the foregoing example. The results can then be compared to existing approved rates and fares. This procedure enables the operator to determine whether or not the new aircraft he is investigating will, in fact, stand a chance of making a profit at existing fares and rates It is purely a matter of the operator's judgment whether or not sufficient traffic can be had to satisfy the demands of the aircraft. It is also a matter of operator judgment what combination of traffic is likely to pay the highest returns

In the case where the selected aircraft is of higher cruising horsepower than the aircraft type used in the operations from which experience statistics are drawn, it must be remembered that the indirect charge per hp -hr. resulting from study of a known operation will be slightly higher than for aircraft of higher cruising power Herein lies a safety margin in preparing the estimated cost of operation of the larger aircraft

For example, executive, administration, and supervisory expense does not rise directly as the cruising horsepower. To illustrate this point, assume that the mechanical airborne cost for the new aircraft works out to 5c per hp -hr., and that the experience figure for all remaining costs in a known operation of lesser-powered aircraft is 10c. per hp -hr. The new aircraft can then be counted on to operate for not more then 15c per hp -hr and most likely will operate for less. The 15c per hp.-hr for the new and larger aircraft should contain ample safety margin, otherwise there is no virtue in mass production

It is suggested that should the reader decide to substitute actual specifications under Items 1 to 19 in our Work Table, he then will likely find that the final cost per hp.-hr. will be closer to 13c. for operations having a reasonable overhead expense.

It is imperative that the operator know the cost of his product if there is to be any precise measure of control over his operating destiny. The two distinct products that the average air transport operator is manufacturing are passenger-miles and pound-miles. The former involves the sale of space primarily. The latter involves the sale of weight carrying capacity. In the first case the weight is assumed to average about 200 lb ; in the second case space is assumed, in that 15 lb of cargo is expected to occupy about 1 cu. ft. of cargo compartment. These assumptions are no excuse for not making a close study of density as it applies to different types of payload. Because of failure hitherto to realize the importance of density, many operators have talked freely in terms of "average cost per ton-mile."

. . . Toward Financial Safety

This is not to say that the present day operation is not being carefully controlled in the interest of safety in its every mechanical detail The operations manager has a larger function, however, in that he is also responsible for the safety of the financial result obtained from operations In this connection, if he does not know the unit cost of his services—namely, the cost of passenger-miles and pound-miles—he can only thank his lucky stars if he turns in an annual profit, because he cannot tell how he got there He most certainly cannot trace where his profit came from by contemplation of rates per ton-mile for all traffic handled

As stated previously, there does not seem to have been any attempt to investigate the cost of operation beyond the cost per hour, per mile, or per ton-mile None of these units is sufficiently specific to enable the operator to arrive at the detailed cost of his two transportation products Though the cost of production may have been found in a general way to be at so much per flying hour, there hitherto has been no way of attaining an equitable distribution of this cost to the various payload elements of the aircraft. This distribution of cost can be accomplished through the medium of the cu ft.-mi Cost of the cu ft -mi can be taken as constant throughout the whole aircraft.

Then by considering density it is possible to arrive at the earning power of each cu ft -mi. This earning capacity does vary with the kind of payload that is packed into it As a rule

(*Turn to page 122*)

WORK TABLE

Sample Specifications and Data Employed in the Power-Space-Density Approach to Economic Analysis of Aircraft Operation

(Arbitrary Figures Based on a Hypothetical Transport Craft)

A. Original Data

1	Cost of airframe	$1 000 000
2	Number of engines	4
3	Cost of each engine	$40 000
4	Total cruising power	5 000 hp
5	Total payload space	5 700 cu ft.
6.	Cargo space	700 cu ft.
7	Cabin space	5,000 cu ft.
8.	Cruising speed	300 mph
9	Number of passengers	60
10	Permissible cargo density	15 lb /cu ft.
11	Passenger weight	170 lb
	a Plus 8 lb for food water	178 lb
12	Free baggage	66 lb
13.	Aircraft utilization	10 hr /day
14	Aircraft life	5 yr
15	Engine life	7 000 hr
16.	Price per passenger-mile	$0.05
17	Price per pound-mile	$0 0003
18	Passenger baggage	25 lb /cu ft.
19	Power-time per aircraft mile, (4)/(8)	16 66 hp -hr

B. General Equations

20	Aircraft life (13) × (14) × 365	18,250 hr
21	Power-time used (20) × (4)	91,250 000 hp -hr
22	Cubic foot-miles per hour (5) × (8)	1,710 000 cu. ft.-mi /hr
23	Horsepower-hours per cubic foot-mile (4)/(22)	0.00293
24	Passenger-miles per hour (8) × (9)	18,000 pass mi /hr
25	Engine life (4)/(2) × (15)	8,750,000 hp.-hr
26	Number of engines required, (21)/(25)	10 48
27	Baggage space (9) × (12)/(18)	158 cu ft.
28	Cargo space for express mail, (6) − (27)	542 cu ft
29	Total permissible cost	
	a. Per pass -mi incl direct cost, (16) − 10%	$0.045
	b Per lb -mi incl direct costs, (17) − 10%	$0 00027

C Mechanical Airborne Cost Per Horsepower-Hour

30	Airframe depreciation (1)/(21)	$0 01090
31	Airframe overhaul cost labor (experience figure)	0 00432
32	Airframe service cost, labor (experience figure)	0 00742
33	Airframe overhaul cost, material (experience figure)	0 00334
34	Airframe service cost material (experience figure)	0 00110
35	*Total*	$0 02708
36	Engine depreciation (26) × (3)/(21)	$0 00456
37	Fuel per horsepower-hour	0 01642
38	Oil per horsepower-hour	0 00066
39	Engine overhaul labor (experience figure)	0 00282
40	Engine overhaul material (experience figure)	0 00584
41	*Total*	$0 03030
42	Total mechanical airborne cost, (35) + (41)	$0 05738
43	Mechanical airborne cost/cu ft.-mi (23) × (42)	0 000168
44	Mechanical airborne cost/pass -mi (7)/(9) × (43)	0 014
45	Mechanical airborne cost/lb mi (43)/(10)	0 0000112
46	Permissible indirect cost/pass -mi (29) − (44)	0 031
47	Permissible indirect cost/lb mi (29b) − (45)	0 0002588
48	Permissible indirect cost for full payload per aircraft mile [(9) × (46)] + [(10) × (28) × (47)]	3 94
49	Permissible indirect cost/hp -hr , (48)/(19)	0 236
50	Permissible indirect cost for 50% payload per aircraft mile, (48)/2	1 97
51	Permissible indirect cost/hp -hr at 50% payload (50)/(19) or (49)/2	0 1182
52	Total permissible cost/hp -hr at full payload (42) + (49)	0 293
53	Total permissible cost/hp -hr at 50% payload (42) + (51)	0 17558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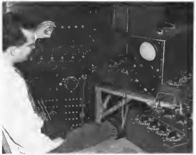
ACETYLENE COUPLING
BLOW GUN
SWIVEL NUT HOSE CLAMP
HANSEN MFG. CO.
1786 EAST 27TH STREET
CLEVELAND 14, OHIO



Using analogue computer, Prof. Warren determines complex flutter velocities in aircraft wings.

Electrical Computor Solves Wing Flutter Problems

Basnd en analngy nxisting between mnchanical and electrical systems, nnw electronic instrnmnnt rnduces timn and labor in calculating wing flntter velocitins.

CALCULATION OF WING FLUTTER VELOCITIES is a problem of considerable mathematical complexity requiring long and tiresome numerical calculations for even the simpler problems. The Department of Electrical Engineering at Ohio State University has developed an electrical analogy computor. Prof. Claude E. Warren, who is in charge of the project, finds that it affords considerable reduction of labor and time required for the solution of flutter problems.

The computor is based on the analogy existing between the equations of performance of the mechanical elements (mass, stiffness, and velocity damping) and the electrical elements (inductance, capacitance, and resistance).

Operation of the computor can be illustrated by considering the wing as a cantilever beam fastened to a fuselage of infinite mass. The wing in general will oscillate in both flexure and torsion, with coupling between both types of oscillation. When the wing is in motion it is surrounded by an airstream which may transmit or receive energy from the vibration of the wing. For flight velocities below the flutter velocity, average interchange of energy between the airstream and vibrational modes of the wing is zero. However, given a flight speed at the flutter velocity, vibrational modes of the wing receive more energy from the airstream than they return, and if this condition of resonance persists, the wing will vibrate to destruction.

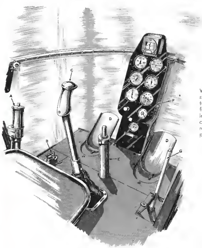
Generally speaking, the wing may be considered as a distributed constant mechanical system with an infinite number of modes of vibration in both torsion and flexure. However, in practice it is usual to consider only a finite number of modes. For the simplest case only the lowest mode for each type of vibration would be considered. Therefore, if only a finite number of modes are considered, the equations of performance of the wing can be reduced by a Rayleigh-Ritz procedure to a set of linear, algebraic equations in terms of the generalized coordinates of the assumed modes. These equations can then be interpreted as an interconnection of electrical circuit elements, where various circuit elements are related to wing physical parameters.

Aerodynamic forces resulting from the airstream are introduced as generalized forces in terms of Theodorsen's well known equations. These forces may be interpreted either as sources of electrical energy or as negative electrical circuit elements. In either case, the forces result in additional coupling paths between various modes of vibration, and each of these paths will contain an electronic amplifier. The entire electric circuit representing the vibrational properties of the wing and its associated airstream may then be considered as a multiple-loop feedback amplifier and its performance can be determined by usual circuit theory.

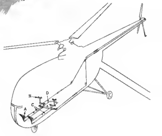
For example, with a given wing, certain elements will depend only on the physical parameters of the wing and others will depend on the reduced velocity which is introduced by the aerodynamic forces. As the circuit elements are adjusted in accordance with various assumed values for the reduced velocity, a certain critical velocity will be found where the circuit breaks into self-sustained oscillation. Flutter velocity of the wing can then be calculated from the known critical value of the reduced velocity. In other words, instability of the analogous electrical circuit is directly related to the vibrational instability of the aircraft wing and its associated airstream.

Accuracy and speed of this analogous electrical procedure can be improved by making impedance measurements in one of the feedback loops and applying Nyquist's criterion for stability of feedback amplifiers.

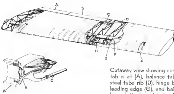
In addition, more complicated problems involving vibratory problems of engine mounts and ailerons can be solved by the computor. The computor is very flexible and should make possible the study of a wide range of wing designs without prohibitive investment of time and effort.



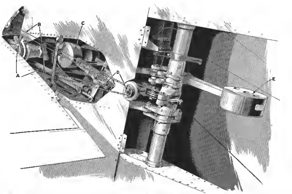
View over front pilot's seat in Firestone G & A XR-9B helicopter. Simulteneous pitch control stick is at (A), fuel primer at (B), longitudinal and lateral control stick at (C), directional control pedals at (D), nose wheel reservoir and strut at (E), instrument panel at (F), and parking brake at (G).



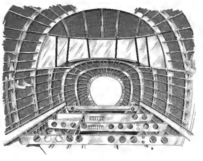
Phantom view of XR 9B directional surface control system, with fore and aft rudder pedals at (A) and (B), respectively, connecting push-pull rods (C) and balance cable (D)



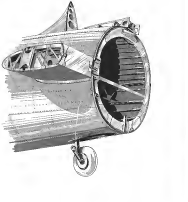
Cutaway view showing construction of Avro Lancaster elevator. Trim tab is at (A), balance tab at (B) mass balance (C), typical welded steel tube rib (D), hinge bracket slot (E), tubular steel spar (F) metal leading edge (G), and balance weight welded to ribs (H). Sketch at lower left gives details of hinge attachment, showing stabilizer rear spar (A), hinge bracket (B) and connecting rod to balance (C).



DeHavilland Hornet elevator and rudder control arrangement, showing elevator control cables (A), rudder cables (B), elevator mass balance (C), sprockets (D) operating on bicycle-type chain and rudder mass balance (E). While main portions of Hornet wing and fuselage are of wood construction, empennage units are metal.



Interior view of Vickers Viking 28 30 place transport, showing fuselage construction at pilots' compartment.



Aft section of Viking fuselage showing inboard section of stabilizer and method of attaching vertical fin. Tail wheel retracts up into fuselage just ahead of former which supports rear stabilizer spar.

SHEET NUMBER .... D-37 (Continued)
CLASSIFICATION .... Processes
SUB CLASSIFICATION .... Quantities

Conversion Factors (General)

PART IV

Unit	Multiplied by	Equals
Mm Hg.	1.3595	Gm /sq cm.
Mm Hg	2.7845	Lb./sq. ft.
Mm Hg	0.019337	Psi
Mils	0.001	In
Mils	25.4001	Microns
Ohm/M. gm.	100 ÷ dens.	Micro./cm. cu.
Ohm/M. gm.	601.5 ÷ dens	Ohm/mil ft
Ohm/mil ft	0.1662	Micro./cm. cu.
Oz. (Av.)	16	Drams
Oz (Av.)	437.5	Grains
Oz (Av.)	28.3495	Gm
Oz (Av.)	0.9586	Oz (water)
Oz (Av.)	0.0625	Lb. (Av.)
Oz (Troy)	480	Grains
Oz. (Troy)	31.103	Gm.
Oz. (Troy)	1.0971	Oz (Av.)
Oz (U. S. fl.)	29.5737	Cu. cm.
Oz (U. S. fl.)	1.80469	Cu. in.
Oz. (U. S. fl.)	1.0432	Oz. Av. water, 39.1°F
Oz. (U. S. fl.)	$\frac{1}{16}$	Pints (U. S. liq.)
Oz./gal.	7.485	G./L.
Pints (U. S. dry)	33.6003	Cu. in.
Pints (U. S. dry)	0.5506	L.
Pints (U. S. liq.)	28.875	Cu. in.
Pints (U. S. liq.)	0.473168	L.
Pints (U. S. liq.)	16	Oz. (U. S. fl.)
Lb. (Av.)	27.6873	Cu. in. water—39.1°F.
Lb. (Av.)	453.592	G.
Lb. (Av.)	7000	Gr.
Lb. (Av.)	15.3378	Oz. (U. S. fl.)
Lb. (Troy)	0.8229	Lb. (Av.)
Lb. (Troy)	5760	Gr.
Lb. (Troy)	373.2417	G.
Lb. water	0.1198	Gal. (U. S.)
Lb./cu. ft.	0.01602	G./cu. cm.
Lb./cu. in.	27.680	G./cu. cm.
Lb./ft	1.488	Kg./m.
Lb./gal.	0.1198	G./cu. cm.
Lb./sq. ft	4.7252×10^{-4}	Atmos.
Psi.	0.06805	Atmos.
Psi.	2.307	Ft. water
Psi.	70.307	G./sq. cm.
Qt. (U. S. dry)	1101.23	Cu. cm.

Courtesy: Reinhold Pub. Corp., *Metals & Alloys Data Book* by S. L. Hoyt.

Tronsport-Cost Approach

(*Continued from page* 107)

the latest and most luxurious aircraft's cabin cu ft-mi takes about 3 lb of passenger, while the cargo compartment is loaded with about 15 lb-mi of freight If you reduce the passenger-mile to pound miles it is easy to compare the earning capacity of the cubic foot in the cabin with that in the cargo bold.

If the operator has not been carrying as much express as he can on his scheduled flights, it would appear as though he has been passing up the opportunity to make that portion of his aircraft pay him real money A little careful thought given to the subject of density will prevent any careless assumptions about it costing the same per ton-mile to transport loads of low density as it does for loads of high density The problem all boils down to the matter of determining the earning value of space in different portions of the aircraft

It should be noted here that there is a difference between the cost of building that space and the cost of moving the same space. It costs a great deal more to build a cubic foot of luxurious cabin than for a cubic foot of cargo compartment. It also costs a great deal more to service a cubic foot of cabin. The earning capacity of each type of space is also different, but the cost of moving them is the same.

To illustrate the direct method for arriving at a passenger fare over a route hitherto not operated and where no fare has as yet been fixed by the government the following procedure is recommended as being simple, direct, and logical Let us initially assume these conditions:

Operating cost, hp-hr	13c
Cruising power	5,000 hr
Cruising speed	300 mph
Cubic cap of craft	5,700 cu ft
Cabin cap baggage space, chargeable to fare	5,158 cu ft
Passengers accommodated	60
Occupancy (average)	80%
Flight (non stop)	1,200 mi
Profit	10%

Using the above data, the following simple mathematical term may be written: (5158/5700 × 5000 × 0 13 × 1200/300 × 110/100)/(80/100 × 60), which reduced is $53 60, or $0 0445 per passenger-mile

The same procedure may be followed to find the indicated rate per pound-mile for express, if we assume that 542 cu ft of the total of 5,700 cu ft. payload capacity of the aircraft is devoted to cargo space at an average density of 10 lb/cu ft Using the above data, the simple mathematical term is written: (542/5700 × 5000 × 0 13 × 1200/300 × 110/100)/542 × 10, which reduced becomes $0 05 per pound for the 1,200 mi trip, or $0 00004166 per pound mile

The above examples show the cost rates, to this rate may be added the profit as dictated by company policy or as regulated by the Government. Our computations demonstrate that fares are based on space, while rates are based on weight at an assumed average density This procedure is in line with the way the traffic departments quote rates to the public

Weakness of the second computation is that it rests on an assumption about cargo density Further study along this line will reveal that classification of express and freight is needed and that this classification will naturally grow from density value of the wide variety of goods being accepted for transport by air.

It is true that there are other considerations in making up classifications of this nature, but from the standpoint of the operators' earning capacity, density study would seem to be the starting point. The operator cannot afford to carry a cargo compartment full of cut flowers at the same pound-mile rate as for machinery parts Unless he is able to operate with all the seats filled he cannot afford to sacrifice earning capacity in the plane's cargo hold

It is the writer's belief that the cargo hold and special mail compartment is an essential part of the passenger plane structure. At present rates the cargo compartment can earn a greater margin of profit on the space used than can be earned in the cabin It is argued that a specialized freight aircraft is required on certain routes, and that where traffic is available for round-trip hauls, a sound business can be operated at pound-mile rates which are less than rates currently charged for express haulage on passenger aircraft.

Analysis of a specialized freight aircraft by the use of the power-space-density units indicates that freight can be handled at rates low enough to attract volume business, provided that aircraft can be kept loaded for every mile flown It would seem like good sense to follow rail practice in that mail and express should be handled on all scheduled passenger operations, while freight should be handled by specialized aircraft and specialized organizations. Because man seems unwilling to pay as much for personal transportation as for his mail or urgent express matter, the operator of passenger airlines needs such cargo to subsidize his passenger business Until recently the operator's income from carrying 1 lb over 1 mi in the various categories of traffic was (approximately) as follows

Airmail	¼ cent
Air express	⅓ mill
Passengers	¼ mill

In recent months airmail payments have come in for scrutiny and pruning It may be that improved efficiency of both the operator and the aircraft warrants rate adjustments. But, very little adjustment is warranted on the basis of improved passenger loadings, since the passenger business is so expensive to handle that no great profit can be realized even from 100% occupancy

In any case, the operator frequently finds his airmail contract a handicap, in that it often interferes with operation of his passenger schedules in accord with passenger convenience. Should airmail rates be cut severely it is possible for the operator to lose interest in airmail carriage Since payments are now made by the pound mile, the operator has to take his chances along with the Post Office Dept in the matter of loadings This seems rather unfair, since he has no means of building up airmail traffic It is suggested that airmail contracts might better be sold on the basis of rental by the Post Office of so many scheduled cu ft-mi. annually; special "mail compartment-miles" also could be used as a unit, when provided. The Post Office would then have exclusive use and responsibility for making the mail compartment a paying proposition The air-

mail contractor would have a steady income from one part of his aircraft at least He would have no vital interest in what was loaded into the compartment, as long as its weight limit was not exceeded The Post Office would, of necessity, begin to study ways to load the compartment to its limit

Airmail should not cost the operator any more to handle than does express; but at the present time it pays more for the weight carried, though this is not always in relation to space occupied In any case, letter mail when packaged and concentrated offers possibilities of very attractive revenue to the Post Office Everything points to a high revenue potential for all concerned if public use of airmail sufficiently increases

The above remarks are prompted as a result of having determined the actual cost of production of transportation for each type of traffic So far as the writer can determine, no system of cost analysis presently in use in the air transport industry attempts to establish the unit cost and price pertaining to various types of payload It is as though one had sold a mixed carload of oranges, grapefruit, and lemons for more than the purchase price; it turns out to be a sound business deal, but no one can exactly allocate where the profit came from. The air transport operator is not in the job-lot business, however; for him it is a "must" to know just where each type of traffic stands in the profit and loss picture.

It seems to be the natural requirement in ordinary business practice that the vendor should know the cost of the goods he is selling The same law applies when one is selling services The air transport operator is selling a service in units of passenger miles and pound-miles He definitely should know what these units cost him to provide

From the writer's viewpoint, this knowledge not only seems easy to come by, but it is also most necessary to have if air transportation is ever going to graduate into the status of an ordinary business with profit as its motive

REVIEW OF

PATENTS

Following are digests and listings of some of the more interesting patents on aviation developments granted through the U S. Patent Office Printed copies of any of these patents are obtainable directly from U. S. Patent Office Washington D C, at a cost of 25¢ each

Engine Cowling features channelled track to permit sliding of arcuate shutter sections to open and close space between shutters and cockpit cowling so as to regulate airflow—2,408,671, filed Nov. 8, '44 pat. Oct. 1 '46, D N Cappan.

Instrument Landing System embodies method of directing radio frequency energy from source through one of plurality of energy wave-guides branching from source to output circuits Reflecting curtain of ionized gas is formed within one and then the other of wave-guides to direct energy successively through respective guides—2,408,425, filed Apr 4 '41, pat. Oct. 1, '46 F A Jenks, D F Folland, A S Macder, and W T Cooke assignors to Sperry Gyroscope Co

Airspeed Indicator incorporates plurality of electron tubes having output circuits connected in parallel Each tube has gas sealed within and electrical output of each is varied in accordance with changes in gas pressure—2,408,861, filed Nov 20 '43 pat Oct 1, '46, A R Lee assignor to Designers for Industry, Inc.

Rotor Airfoil has tipend region in form of wedge-shaped entering edge and open trailing edge Intakes are spaced inboardly from tip so that air is drawn in and centrifugally flung outwardly and to rear of tip end to minimize drag at critical compressibility tip speeds Means controlling open trailing edge is responsive to blade movement.—2,408,788, filed June 16, '39, pat Oct 8, '46, C T Ludington.

New Wing Heating Apparatus comprises means for radiating heat energy as beam lengthwise of airfoil and for deflecting portions of beam against leading edge—2,406,567, filed July 22, '42, pat Oct 8, '46 H J De N McCollum

Engine Extruded Piston has spaced bosses integral with head extending in free spaced relation with skirt and terminating substantially in plane of skirt open end Bosses have aligned bores for receiving piston pin. Swaged flange around open end of skirt projects inwardly over skirt interior surface—2,408,875, filed Dec. 8, '42, pat. Oct. 8, '46, W A Parkins, assignor to United Aircraft Corp

Landing Wheel Rotator, disposed in receiving well, is power-actuated to move out of well into airstream to cause wheel rotation—2,406,663 filed June 14, '43, pat Oct. 8, '46, L L. Westcamp.

Aircraft Warning Siren is located at substantially narrowest cross-sectional region of air duct extending from air intake to air outlet openings in fuselage Air scoop conforms with surface contour of fuselage when scoop is retracted—2,408,131, filed Aug 24, '43, pat Oct 8, '46, W T Lear, assignor to Lear, Inc.

Aircraft Hydraulic System includes indexing valve actuated by driving means so as to connect system to pressure at one extreme of movement of driving means and to exhaust at other extreme—2,409,175, filed Oct. 16, '42, pat Oct 15, '46, A H Adams, and T S Tucker, assignors to Bendix Aviation Corp

Rocket Launching Device comprises carriage normally positioned in open bay of airplane fuselage, coupled to pivoted strut for positioning carriage beyond propeller arc in line of travel parallel to airplane thrust line Rockets are mounted on underside of carriage.—2,409,216, filed June 18, '45, pat Oct 15, '46, C H Jolly

Fuel System features plurality of storage tanks, each having sump in which pump is mounted When liquid level reaches sump, pump stops, then pump in next full tank is actuated—2,409,245, filed Aug 12 '44, pat Oct 15, '46, J B Black, assignor to the Glenn L. Martin Co

Other Patents

Cylinder Construction, 2,408,427, filed May 11, '40 pat Oct 1 '46, A Kalitinsky assignor to United Aircraft Corp

Rotary Wing Aircraft, 2,408,489 filed Jun 29 '42, pat Oct 1, '46 E A Stalker

Propeller Spinner, 2,408,677 filed Aug 24 '40 pat Oct 1, '46 F Morgan, assignor to Rotol Ltd.

Aircraft Temperature Control, 2,408,669, filed Nov 30 '42 pat. Oct 1 '46, H T Sparrow assignor to Minneapolis Honeywell Regulator Co

Jet Propulsion Engine, 2,408,749, filed Oct. 7, '43, pat Oct 8, '46, A G Elliott

Spray Tank for Aircraft, 2,408,774 filed Apr 24 '42 pat Oct 8, '46, R Goddard and F R. Weaver

Automatic Volume Control, 2,408,821, filed July 30, '42 pat Oct 8 '46 H M Stearns, assignor to Sperry Gyroscope Co

Landing Gear Actuator, 2,408,862, filed Jan. 28 '44, pat. Oct 8, '46 R. M Nardone, assignor to Bendix Aviation Corp

Landing Hook Reeling Mechanism, 2,409,182 filed Oct 20 '43 pat Oct 8 '46, W P Lear assignor to Lear Inc.

Jet Propulsion Turbine, 2,409,177, filed Apr 1, '42 pat Oct 15 '46, R C Allen and J T Rettaliata assignors to Allis-Chalmers Mfg. Co.

Follow-Up and Anti Hunt Mechanism, 2,409,288 filed Dec 31, '46 pat. Oct 15, '46, G S Miles, assignor to Bendix Aviation Corp

Weight and Balance Indicator, 2,409,316, filed Oct. 25 '43, pat Oct 15, '46, F A Piper, assignor to The Glenn L Martin Co

Oxygen Demand Regulator, 2,409,327, filed Mar 3, '43 pat Oct. 15, '46, L A. Wiggins

Fuel Pump, 2,409,665, filed Apr 10, '44, pat. Oct. 22, '46, S M Udale, assignor to G M and E Holley

Airplane Power Plant, 2,409,446, filed Nov 10, '41, pat. Oct. 16, '46 V H. Pavlecka and J K. Northrop, assignors to Northrop Aircraft Inc.

Gyroscopic Control, 2,409,634, filed Jan. 16, '43, pat Oct. 22, '46, A W Lane, assignor to Sperry Gyroscope Co

Bombsight, 2,409,648 filed Jan 25 '41, pat Oct 22, '46 H C Van Auken and G

HAS ROOM TO SPARE

Carries 4 people and luggage or pilot and 645 lbs. of cargo

Built for comfortable 500-mile flights at a high cruising speed, the four-place, all-metal *Navion* can carry a useful load of over half a ton. The baggage shown in the picture below fits easily in the *Navion's* spacious trunk compartment. Glove and map compartments and a wide shelf provide additional space and the *Navion* has plenty of leg and elbow room for four big people. By removing the rear seat, two persons can fly with 455 pounds of cargo. The pilot alone can carry 645 pounds in the 55 cubic foot cargo space. For further details about the *Navion's* utility for business or pleasure . . . write Dept V-7, North American Aviation, Inc., Los Angeles 45, California. Standard model, $6,100 f.a.f.

CAA Approved Type Certificate 782

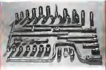
BUY CHRISTMAS SEALS

Designed and built by

NORTH AMERICAN AVIATION INC.

The Navion is built by the creators of the famous P-51 Mustang, P-82 Twin Mustang, XFJ 1 Navy jet fighter, P-86 Army jet fighter, B-45 Army jet bomber and other advanced-type aircraft

. . . When you're glad you have a Snap-on



SNAP-ON FERRET WRENCHES

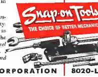
Here's a set of 38 Ferret units including complete handle equipment and an assortment of sockets in standard Hexagon, extra deep Hexagon, Hexagon Flexockets and square sockets. They're twice as strong as you would expect such slender handles and shallow, thin-walled sockets to be.

Photo, courtesy of Northwest Airlines, St. Paul, Minn.

Tightening ground lead nuts on the starter with a sturdy Snap-on Ferret Ratchet . . .

Snap-on Ferret Wrenches (3/8" drive) are favorites with aviation mechanics because of the speed and ease with which they can be used . . . even in hard-to-get-at places.

The Ferret Reversible Ratchet (illustrated above) is "tops" in popularity. It has such outstanding features as *hardened bearings* inserted in the head, plus *surface carburized steel base plates* to prevent wear . . . *precisioned machined gears and pawls* for free-working action . . . a sanded grip, fashioned for comfort . . . and high quality chrome finish. In every way, it is built to outlast and outperform similar ratchet wrenches.



Snap-on tools are available through a nation-wide direct-to-user tool service. "Ask your Snap-on man" . . . or write for complete catalog of 4,000 Snap-on tools.

SNAP-ON TOOLS CORPORATION | 8020-L 28th Ave., Kenosha, Wisconsin

N Hanson assignors to Sperry Gyroscope Co

Gyro Vertical, 2,409,588, filed Apr 19 '41, pat Oct 22 '46, F D Bradden, assignor to Sperry Gyroscope Co.

Hydraulic Selector Valve, 2,409,765, filed May 4, 46 pat Oct 22 46, O A Kehle, assignor to Adel Precision Products Corp.

Adjustable Harness Clip, 2,409,772 filed May 13 '44 pat Oct 22 '46 C Lund, assignor to Adel Precision Products, Corp

Gyro Assembly, 2,406,675, filed July 28, 44 pat. Oct. 22 46 R G Martin, assignor to Jack & Heintz Precision Industries, Inc.

Recent Books

Thumbnail reviews of selected aviation books and pertinent business and industrial texts.

AIRCRAFT WOODWORK, by Col R. H Drake The Macmillan Co , New York City 197 pages, illustrated. $3.50

There is much useful data in this volume on the various types of woods—their physical characteristics, structure identification, uses specific requirements in strength, and seasoning for different aircraft parts. There is equally full and specific details about various types of glues used in woodworking also techniques of application

INCENDIARY WARFARE, by George J B. Fisher, Col Chemical Warfare Service, USA McGraw-Hill Book Co., New York City 125 pages, illustrated $3 00

Described here are techniques of producing fire with military projectiles, ground and air, and tactics followed in aerial incendiary bombardment Book makes available much material which had been under secrecy regulations

MATHEMATICAL AIDS FOR ENGINEERS, by Raymond W Dull McGraw-Hill Book Co., New York City, 346 pages, illustrated. $4 50

This book provides engineers with many basic mathematical tools essential to dealing with higher mathematics involved in present day engineering developments Many topics under discussion are new and more common ones are presented with new applications, thus increasing their usefulness

MEXICAN-AMERICAN CONFERENCE ON INDUSTRIAL RESEARCH Illinois Institute of Technology, Chicago, Ill 176 pages $2 50

These proceedings of Mexican American conference should prove of particular interest and service to research directors, consulting engineers and technical directors of companies whose postwar planning committees are considering ments of intensified activity with our neighbors south of border

MANAGEMENT TECHNIQUES FOR FOREMEN, by Richard W Wetherill National Foremen's Institute Inc, Deep River, Conn. 177 pages $7 50

Particularly designed for foremen managing production workers, this manual is indexed so that when faced with a problem, foreman-reader may quickly turn to heading which comes closest to it. Answers are furnished by other foremen who solved similar problems

STATISTICAL QUALITY CONTROL, by Eugene L. Grant McGraw-Hill Book Co New York City 563 pages, illustrated $5 00

Object of this manual is to explain with simple but concise statistical techniques how industry can reduce costs and improve product quality Most effective use of methods depends upon their being understood cooperatively by production and inspection supervisors by engineers, and by management

HOW TO TAKE PHYSICAL INVENTORY, by Richard F Neuschel and Harry T Johnson McGraw-Hill Book Co, New York City 159 pages $2 00

A plain and practical guide, presenting principles and techniques for planning and effecting physical inventory including development of inventory-taking organizations and required procedures. Appendix contains a detailed manual of instructions applying principles given in text

AIRCRAFT CARBURETION by Robert H. Thorner John Wiley & Sons New York City, 393 pages, illustrated $3 50

This volume is concerned only with fundamental principles of carburetors and related equipment maintenance overhaul and design considerations having been omitted in order to present concise and uninterrupted discussions of the operating principles. There is special emphasis on pressure, pressure measurements and pressure instruments, and operation of fuel pump and superchargers in relation to carburetor and engine

Aviation People

Eugene E Wilson (photo) has resigned as chairman of board of United Aircraft, but will continue as a director He joined company in '30 as pres of Hamilton Standard Propellers Div, after having served as comdr in Navy for 25 yr He was pres of corporation '40 to '43 and is chairman of AIA. (John Haley photo) **James S. Lee** has been appointed European representa-

H. H. Monsey

E. E Wilson

tive for United **Wayne M. Pierce** was made chief of design operations at Chance Vought Div, and **Ernest J. Mailloux** and **Fred N. Dickerman** were named asst chief engineers

Herbert H Munsey (photo), patent counsel for Bell Aircraft, has been named chairman of patent advisory committee of Manufacturer's Aircraft Assn He has been a director of organization for past 18 mo

F. H. Hankins, Jr, (photo) has been appointed division operations mgr for PAA's Atlantic Div He joined airline

F. H. Hankins, Jr.

J. L. Bialock

in '33 as an apprentice pilot, and holds a BS degree from Dartmouth and a BS degree in engineering from M.I.T. He was awarded special merit citation by War Dept for outstanding work during operation of line's Africa-Orient Div **Joe Lewis Bialock** (photo) was named chief flight engineer of At-

Are you keeping your eye on STAINLESS STEEL?

You can bet that Mr. Solar has *his* eye on Stainless Steel, because stainless fabrication is Solar's specialty. And those of you who are keeping up with jet propulsion and gas turbines have an eye on stainless steel and know the vital part it plays.

But if for any reason you have *not* kept right up to the minute with developments in stainless fabrication—particularly Solar's exclusive Sol-A-Die process—you may not realize that today Solar is solving (or short-cutting) problems in stainless steel that once stumped the experts.

So if you are using stainless parts or equipment (in aviation or any other industry), you may find that Solar's fabrication methods will save you time and money. Or if you *ought* to be using stainless steel, Solar may be able to point the way. Write or call Solar today.

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SOLAR DIVISIONS AND SUBSIDIARIES
Aircraft Manifold Division
Dairy Equipment Division
Stainless Castings Division
Fondo Film Processing Equipment Division
Hubbard Cooker Company

SOLAR AIRCRAFT COMPANY • SAN DIEGO 12, CALIFORNIA • ALSO, DES MOINES 5, IOWA • 60 EAST 42ND ST., NEW YORK 17, N.Y.

1929

FIRST SYNTHETIC COATING FOR AIRCRAFT—Early plywood-winged transports, forerunners of today's all-plywood aircraft, were finished with the first synthetic coating commercially produced for aircraft—one of a long line of finishing firsts scored by the Murphy Varnish Company, recently joined with Ault & Wiborg to form the Finishes Division of Interchemical Corporation.

WORLD WAR II

THE FINISH THAT MADE WAR PLANES INVISIBLE—Another Interchemical first was the development of a "Mirror Black" paint for aircraft which had 1/50 the diffuse reflectivity of the dullest mat blacks previously produced. Use of "Mirror Black" on night fighters and bombers made them virtually invisible in the glare of enemy searchlights. This Interchemical Finish contributed much to the success of the Army Air Force's famed P 61, "Black Widow," in the Pacific Campaign and in night operations over Japan.

TODAY

"A MURPHY AIRCRAFT FINISH"* FOR EVERY TYPE AIRCRAFT—Murphy Aircraft Finishes, because of their characteristic high solids content, blush resistance, flexibility of film, freedom from "orange peel," and good covering qualities, have been responsible for substantial savings in finishing time and production costs. If you are planning to manufacture a new model, having trouble with your present finishing or refinishing operation, or are planning to change and modernize your production line set-up—REMEMBER—To give your product a good start, give it "A Murphy Aircraft Finish."

Write: Interchemical Corporation, Finishes Division, Empire State Bldg., 350 Fifth Ave., New York 1, N. Y.

*Made by the Interchemical Corporation, Finishes Division, a result of the recent consolidation of the business of Ault & Wiborg Division of Interchemical Corporation and that of the Murphy Varnish Company, both manufacturers of fine industrial finishes for more than 75 years.

MURPHY AIRCRAFT FINISHES

AN INTERCHEMICAL PRODUCT

Makers of a complete line of Finishes for Fabric, Aluminum, Duraluminum, Plywood, Fabric Covered Plywood, and Fabric Covered Aircraft ..Paints for Aircraft Marking and Maintenance.

lantic Div, where he will be in charge of all flight engineers' training and scheduling. Prior to joining company in '33, he operated a flying school in Tampa. He participated in most of flight engineering pioneering work of PAA's Sikorsky-type planes and in Boeing Stratoclippers.

Edwin A. Warren (photo) has been appointed mgr. of cargo airplane sales for Glenn L. Martin. Previously, he was v-p of operations for Slick Airways, and is an experienced civilian and military pilot. He has also been associated with Curtiss Aeroplane & Propeller Co., and Intercontinental

E. A. Warren J. J. Fauteux

Corp, and holds a mechanical engineering degree from Purdue. **Henry S. Curtis** has been named mgr. of Glenn L. Martin's new plant at Painesville, Ohio, and **Emile W. Milan** has been made supervisor of production.

James J. Fauteux (photo) has been named mgr. of traffic activities in Orient for NWA, and will go to Far East countries in late fall to open traffic offices. Before joining airline in '39, he traveled abroad extensively during association with Thomas Cook & Son, travel agents.

Paul E. Richter has been named gen. mgr. of transcontinental div. of TWA, and **T. B. Wilson,** board chairman, has been appointed gen. mgr. of international div.

Beckwith Havens (photo) has been named sales director of Embry-Riddle, with Miami and N. Y. hq. He recently completed service with Navy as lieut. comdr., and was officer-in-charge of Air Ferry Training at Willow Grove, Pa., and commanding officer of Navy airfield at San Julian, Cuba. He is also

B. Havens Capt. W. L. Gore

a veteran flyer of World War I, and in '10 became first man to be appointed an airplane salesman by an American manufacturer.

Capt. William L. Gore (photo) has joined Aerojet Engineering Corp as eastern representative, with Wash. hq. A pioneer in development of jet propulsion, he served 12 yr. in Marine

Corps, and was active in Navy's flight testing, installation, and fleet indoctrination in use of Jato. Prior to his release, he was officer-in-charge of A-26 Flying Laboratory at NAS, Mojave, Cal. He is a member of IAS.

R. B. Kenty (photo) has been appointed v.-p. in charge of domestic sales for Air Associates, Inc. Prior to joining company in '34, he was with Curtiss-Wright Flying Service, and has been active in Aviation Distributors & Manufacturers Assn. He is a member of NAA and Texas Private Flyers Assn.

R. B. Kenty **A. H. Endlekofer**

A. H. Endlekofer (photo) has been appointed mgr. of company's Los Angeles branch. Previously, he was associated with Eclipse-Pioneer Div. of Bendix as factory mgr.

Leighton M. Harvey has been named sales engineer for Metal Products, Div. of Ryan.

C. D. Frazer has been appointed to direct activities of Air Power League, succeeding **Jacob E. Smart,** who resigned.

W. R. Gillen has been named director of sales promotion for C&S, and **John J. Shad** has been appointed director of station sales.

William C. Scurry has been elected to board of directors of Luscombe.

William M. Allen, Boeing's pres., has been elected vice chairman of Western Region Exec. Committee of Aircraft Industries Assn.

Lt. R. A. Penrose has been named plant representative for BuAer.

W. P. Hoare has been appointed director of maintenance for UAL, and **O. T. Larson** has been named asst. v.-p.-operations.

George O. Neville has been appointed v.-p. and gen. mgr. for National Skyway Freight.

Bert Zimmerly, founder-pres. of Empire Airlines, has resigned to devote his time to his fixed base flying school and charter operation, but will continue to serve on Empire's board of directors. **F. de Wolfe Sanger** has been named mgr. of reservations and ticket offices for company.

Thomas Ryan has been elected chairman of board of MCA.

Sherman M. Fairchild has been elected chairman of board of Fairchild Industries, and **James S. Ogsbury** has been named pres. and a director.

Harold B. Seifert has been made v.-p. in charge of operations for Pioneer Air Lines.

Robert J. G. McClurkin has been ap-

Exide

AIRCRAFT BATTERIES

FOR DEPENDABLE PERFORMANCE IN EVERY TYPE OF PLANE . . .

Whether your battery requirements are limited to ignition and small lighting loads or call for multiple duty, you will find an Exide designed specifically to meet each particular need. And whatever the type, you can rely on it fully for safety and dependability . . . for longer battery life . . . for maximum performance per pound of weight.

Exide pioneered in the development of aircraft batteries, and has steadily kept pace with aviation's increasing needs . . . with the result that Exides are the battery choice of aviation engineers, maintenance men, plane builders and plane owners.

The Exide Aircraft Battery Sales and Service Organization covers the country from coast to coast.

THE ELECTRIC STORAGE BATTERY CO., Philadelphia 32
Exide Batteries of Canada, Limited, Toronto

Type 12TS-9L
24 Volts
MILITARY TYPE BATTERY
For converted Government planes

Type 3AC7
6 Volts
LIGHT PERSONAL PLANE BATTERY
For ignition and small lighting loads

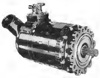
Type 6FHG13
12 Volts
AIR TRANSPORT BATTERY
Used by leading airlines

Type 6TS9F
12 Volts
PERSONAL PLANE BATTERY
For lights, radio and starting

Type GT13
12 Volts
ADVANCED TYPE BATTERY
Used in Jet propelled planes

To achieve the safest amphibian yet in designing its sensational new Mallard, Grumman Aircraft searched painstakingly for the very best part for every job. A Leece-Neville generator, backed by an outstanding record in wartime aviation, was finally chosen for the electrical system. But the standard model didn't quite fit Grumman's special requirements. Leece-Neville engineers went to work at once—soon had ready for production a modified unit which met the Grumman specifications exactly.

Specialists in the design and manufacture of special electrical equipment for over 36 years, Leece-Neville is generally able to answer unusual requirements by modifying existing designs—saving the customer time and money. But modified, designed from scratch, or standard type, your Leece-Neville aircraft electrical equipment will be the very finest available anywhere. Countless satisfied customers will tell you that our people don't know how to build otherwise. *The Leece-Neville Company, Cleveland 14, Ohio.*



Type O-1 Leece-Neville generator which was quickly modified for service on the new Grumman Mallard.

LEECE-NEVILLE

Pioneer and STILL Quality Leader

GENERATORS • VOLTAGE REGULATORS • SWITCH RELAYS • PUMP MOTORS

pointed asst. director of Economic Bureau of CAA.

E. E. Shumate is now N. Y. regional mgr. for Airquipment.

Dr. B. J. Miller has been named chief of Guided Missile Electronics Section of National Bureau of Standards.

AOA appointments: **Ben G. Wright** has been named director of pub. rel., **W. Holden White** has been made European director of pub. rel., **Kenneth Murdoch** was elected asst. sec'y.

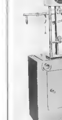
What's New

(Continued from page 17)

moved and locked in place at any point within range of 0.200 to 2.000 in. Both gaging anvils are adjustable for desired pitch by rotating on their mounting shafts. Calibrations on mounting blocks facilitate setting. To permit setup to be made with gage blocks inserted between inner faces, each anvil's inner face is held parallel to center line of disk. For most accurate checking, setting should be made with a master thread gage. Work table is adjustable, as indicated by calibrations on side of table, enabling checking of parts up to 2 in. dia.

Materials Tester 17

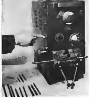
Built for light materials or small finished items, new low-range materials tester made by **W. C. Dillon Co.**, Chicago, incorporates four separate capaci-



ties shown individually on dial. Ranges are: 0-10 lb. in 1 oz. divisions, 0-25 lb. in 2 oz., 0-50 lb. in 4 oz., and 0-100 lb. in 8 oz. Its lower grip travel is continuously variable, or stepless, from 0 to 15 in. per min. It has pendulum type, maximum load reading, swivelled upper grip, stroke limiting switches, stress-strain recorder, forward-reverse switch, and elongation gage. It is stated to have ½ of 1% accuracy. Overall height is 63 in. and weight 162 lb.

Flash Butt Welder 16

Designed for production welding of bar and round stock up to 5/16 in. dia., new portable flash butt welder, Model DBW-3A, made by **The DoAll Co.**, Minneapolis, can be used for repairing small tools, also for butt welding tool



bit extensions and shanks, and for joining band saw blades from 1/16 to 1½ in. in width. Its features are: Built-in grinder for weld dressing, automatic motor controlled feed of material, and cam operated clamping. Welding is automatic, complete cycle being controlled by single, pushbutton switch. In addition to welding, annealing, and flash dressing, it also has an etching attachment. It is designed for standard 220v. a.c., single phase, 50/60 cycle operation, is furnished either in pedestal type or in a metal carrying case. It can also be supplied in other voltages.

Connector Block 19

Providing means of electrical connection for up to 24 pairs of wires, new connector block made by **Aircraft-Marine Products**, Harrisburg, Pa., has been designed to permit connection of solderless knife-disconnect splicing terminals within their own length. By means of these terminals attached to their ends wires are connected to either side of integral metal members that fit in place within plastic body. These parts are held in place by insulated or metal screws. Replacement of insulated screw with a metal screw provides means of interconnecting any two adjacent members. Connection is made by inserting terminal vertically into a well in block and pulling back on wire. Cover is held by spring clip brackets. Block may be cut to desired length for any one installation.

Vacuum Tube Voltmeter 20

Televiso Products Co., Chicago, announces new vacuum tube voltmeter, Series 200A—a direct reading instrument featuring a full scale sensitivity of .5v. for use at radio and audio frequencies. Readings are stated to be as low as 100,000 microvolts. Stray capacitances and detuning effects are reduced by bringing input connections of meter as close to circuit to be measured as possible. Connections can be made directly to measured circuit by lead wires or by a contact clamping fixture for production work. It has external probe,

It's Roebling "Stratocord" for the World's Biggest Bomber

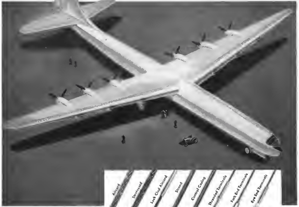
DWARFING the familiar B-29, the largest landplane ever seen is the XB-36, built and test-flown by Consolidated Vultee for the Army Air Forces. This 6-engined monster's wing spread is 230 feet, its length 163 feet, its range 10,000 miles. The tail alone is 5 stories high.

Designed for sub-stratosphere flight, a super-heavyweight like this must have something "special" in control cord. That's why "Stratocord" was called in to play a part in this milestone of the air.

Something new from Roebling, "Stratocord" is made from a *specially* developed steel alloy, with a coefficient of expansion very nearly as high as the duraluminum airframe itself. This practically synchronizes the expansion or contraction of control cord and airframe . . . virtually eliminates over-slack or over-tight control cords.

You'll find all the other "musts" for top performance in "Stratocord" too . . . great strength in small diameter, flexibility, peak fatigue resistance, plus a *new* low in constructional stretch. The full story is worth knowing. Write for the facts.

Aircord Division
JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
Branches and Warehouses in Principal Cities



Other Roebling Aircraft Products include Wire Rope, Slings, Electrical Wires & Cables

ROEBLING

PACEMAKER IN WIRE PRODUCTS

THE PROPELLER WITH PERFORMANCE

SOMETHING *New* ON THE NOSE

OF THE *New* CULVER

A new ship by Culver; a new propeller by Sensenich . . . it's a *right* combination!

Culver's first post-war presentation —the Culver "V"—is now on the line warming up for its flight into the future . . .

. . . and *right on its nose* is the new *Skyblade*—hot off Sensenich's production line—to add "pull" to every horsepower. It's the lightweight, two position, controllable pitch *propeller with performance* made by the world's largest manufacturer of wood aircraft propellers. Culver is first to specify the *Skyblade* as standard equipment. Other models—both controllable and ground adjustable—are approved for other aircraft.

SENSENICH *Skyblade*
TRADE MARK

Wherever you see aircraft, you see the famous Sensenich winged trade mark. No other propeller has been chosen so often by those who design and build America's personal planes—and those who fly them!

SENSENICH BROTHERS • Main Plant, LANCASTER, PA. • West Coast Plant, GLENDALE, CALIF.

to which connections can be soldered, and binding posts that can receive wires or banana plugs. Input tube is a plate circuit rectifier in which input voltage is rectified under full wave square law operating conditions and indicates rms values. Rear storage compartment of instrument contains a source of calibration voltage stated to be equal to 5 rms plus or minus 2%. Chassis, of aluminum alloy, caustic dipped, holds all components except meter, and is held to front panel by four studs. Connecting wires to meter, switch pilot light, and calibration jack are long enough so unsoldering is not necessary when servicing is required. All resistors used for calibration are stated to have only negligible temperature drift. All capacitors are oil, paper, or mica. Cabinets are copper lined to prevent extraneous radio frequency fields from affecting operation accuracy.

Offers Nylon "Soft" Hammer 21

Use is seen in aviation field for new nylon-faced "soft" hammer developed by **Danielson Mfg. Co.,** Danielson Conn. It is said not to chip or mushroom, to have no rebound, to be resistant to fire chemicals, and oils, and not to heat up or change shape under continued use. At present it is available in 2/3 and 2 lb weights.

Radio Receiver 22

Using 140v. plate supply to give high component reliability, and designed into a panel 5¼ in. high, new fixed frequency VHF radio receiver, **RV-1-B** made by **Radio Receptor Co.,** New York City, is designed to meet requirements of airlines. It is stated to produce undistorted audio output of 1w over a frequency range of 100 to 162 mc, with a signal to noise ratio of better than 2:1 for a 2 microvolt signal modulated 30%. Selectivity curve of unit is said to show it to be more than 40 kc wide at 2 times down, less than 110 kc wide at 100 times down, and less than 200 kc. wide at 10,000 times down. It has peak noise limiter to automatically clip impulse noise, also a snap action switch to open audio channel when receiving carriers of 2 microvolts or more. Set is designed for either local or remote control.

No Pit Parts Washer...........23

Requiring no pit or cement work and designed for washing of parts on racks, new spray type washing machine has been announced by **Optimus Equipment Co.,** Matawan, N. J. Top of unit is at working height, and all connections are accessible. Lever-operated valve starts spray, and nozzles are adjustable and replaceable. Machine can also be used with submerged agitation.

Special Adhesive for Bonding 24

Recommended for bonding buna-N type synthetic rubbers and vinyl films or sheet stocks to rigid surfaces (such as steel, aluminum, glass, wood, or concrete) new synthetic, waterproof adhesive, stated to be more resistant to oxidation than similar natural rubber compounds, is announced by **E. I. duPont de Nemours & Co.,** Wilmington, Del. Designated as No 5118 "Fairprene" adhesive cement, material is a thermoplastic elastic composition that does not require vulcanization to obtain maximum adhesive strength. Cold setting, it will dry to a tacky surface, under average conditions, in 3 to 10 min. and dry completely in 2 hr. Although aromatic hydrocarbons will destroy bond, oils or straight gasoline will only weaken bond slightly. Reported to be unaffected by temperatures as low as 40 deg., strength is weakened at 180 deg. and above.

Cleaner-Polisher for Aluminum 25

Specially formulated for airplane maintenance, "Klad Polish", aluminum cleaner and polisher, made by **R. M. Hollingshead Corp.,** Camden, N. J., is stated to remove dirt, grease, grime, and oxidation which make a plane dull and dingy, and in a single operation give a polish to plane's aluminum surface. It is also said to remove corrosion, water marks, oxide film, and burned spots from unpainted aluminum surfaces. It is non-corrosive and non-inflammable.

★ Information Tips ★

ENGINEERING DATA

Insulating Felt 26

Containing technical data for working out felt requirements, Data Sheet No 3 from **American Felt Co.,** Glenville, Conn. describes "K" felt, a combination of kapok and other fibers designed for sound absorption and thermal insulation.

Machining Aluminum 27

Manual issued by **Reynolds Metals Co.,** Louisville, Ky., titled "Machining Aluminum Alloys," includes data on recommended tooling, speeds, and feeds for various machining operations, as well as information on machining characteristics of different aluminum alloys, machining conditions, tool materials and designs, cuts, speed, and feeds, lubricants, coolants and cutting compounds.

High Speed Drills 28

Chart issued by **Chicago-Latrobe Twist Drill Works,** Chicago, covers feeds and speeds for high speed drills from 1/16 to 1 in. when drilling cast iron, steels, and metal alloys.

Welding Alloy Chart....................29

Listing by groups, classes, and trade names alloys used in resistance welding field, chart, "Comparative Resistance Welding Alloys", from **Ampco Metal,** Milwaukee, gives physical properties and technical data.

Soluble Coolant Oil....................30

Use of special soluble oil as coolant and lubricant in cutting, machining and grinding operations is subject of new booklet from **Oakite Products,** New York City.

PRODUCTION

Carbide Tools 21

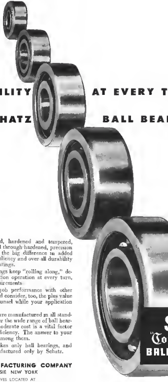
Vascoloy Ramet Corp., North Chicago, has issued new catalog listing standard carbide tools and blanks with new items including shell end mills, solid and tipped boring tools, threading tools, face mill cutter blades, stop cutter blades, scraper blanks, and carbide tipped scribers.

Welding Electrodes......................32

New flux coated metal arc electrodes announced by **Eutectic Welding Alloys Corp.,** New York City, are stated to permit a.c. d.c. metal arc welding on stainless steel at lower base metal temperatures.

Striping Tool 33

Made smaller in dia. to facilitate handling and incorporating tubular glass paint fountain, new painter's striping



EXTRA-UTILITY AT EVERY TURN

WITH SCHATZ BALL BEARINGS

High-grade, carburized, hardened and tempered, cold-rolled steel rings and through-hardened, precision chrome steel balls make the big difference in added load-bearing capacity, resiliency and over all durability of "Commercial" ball bearings.

That's why these bearings keep "rolling along," delivering efficient anti-friction operation at every turn, whatever the service requirements.

Compare their on-the-job performance with other low-cost ball bearings. And consider, too, the plus value of Schatz engineering counsel while your application is in the design stage.

Schatz "Commercials" are manufactured in all standard types and sizes to cover the wide range of ball bearing applications where moderate cost is a vital factor alongside of maximum efficiency. The answer to your anti-friction problem is among them.

Remember, Schatz makes only ball bearings, and "Commercials" are manufactured only by Schatz.

SCHATZ "Commercial" BALL BEARINGS

THE SCHATZ MANUFACTURING COMPANY
POUGHKEEPSIE NEW YORK

REPRESENTATIVES LOCATED AT
Detroit 2640 Book Tower—26 • Cleveland 402 Swetland Building—15
Chicago 8 S Michigan Ave—3 • Los Angeles 5410 Wilshire Blvd—36

THE LOW-COST, MULTI-PURPOSE BALL BEARING

William "Bill" Ong (left) President ONG AIRCRAFT CORPORATION, Kansas City, Missouri—Kansas and Missouri Distributors for REPUBLIC AVIATION CORPORATION—takes delivery of the first of 150 Seabees he has on order from Gordon Sleeper, Sales Manager, Personal Plane Division of Republic.

Seabees are Equipped with ELECTROL HYDRAULICS

Concerning this equipment, Mr. Ong writes:

"I have been tremendously pleased with the ELECTROL HYDRAULIC SYSTEM on my Republic Seabee Amphibion. One of the best things about the Seabee is its splendid landing characteristics. Such is the efficiency of the ELECTROL LANDING GEAR that it is difficult to make a bad landing with this airplane. I have been operating our Seabee demonstrator out of some very difficult landing strips which are frequently rough and rolling, and the gear has taken a terrific beating. Despite abnormally hard usage we have not yet seen a field that is too rough for the Seabee to handle.

"To date we have had no occasion to service the gear because it has given us absolutely no trouble."

ELECTROL INCORPORATED

FOR BETTER HYDRAULIC DEVICES

KINGSTON, NEW YORK

Cylinders	Selector Valves	Follow-up Valves	Check Valves	Relief Valves
	Hand Pumps	Powerpaks	Oleo Struts	
Solenoid Valves	On-Off Valves	Servo Cylinders	Transfer Valves	Cut-Out Valves

tool is described in catalog page issued by **Wendell Mfg. Co.**, Chicago

Chemical Cleaner 34

Information available from **Hartman Corp of America**, St Louis, Mo., describes new portable chemical cleaner electrically heated and employing atomized spray of water

Grinding Wheels 35

Folder from **Norton Co.**, Worcester, Mass describes "Alundum 32" new aluminum oxide abrasive made by a new process.

MACHINERY & ACCESSORIES

Gages 36

Bulletin issued by **Sturdy Tool & Gage Co.**, Detroit, covers line of chromium plated steel, tungsten carbide, and Nor blide gages

Flute Grinder 37

Grinding straight flutes or spiral points of taps new flute grinder is described in Bulletin No 410 from **Edward Blake Co.**, Newton Center, Mass

Mechanical Pressure Gage 38

Catalog page issued by **W C Dillon & Co.**, Chicago, describes line of mechanical pressure gages for checking pressures from 0 to 6000 lb between static or moving parts

Drilling and Tapping 39

Bulletin No 31 published by **Ettco Tool Co.**, Brooklyn, N Y concerns system and equipment for multiple drilling and tapping of small parts

Small Chucks 40

Developed to permit changing of tools without stopping machine new chuck made for use on small machines and hand power tools is covered in folder from **Rayco Mfg Co.**, Chicago

High Speed Drills 41

Republic Drill & Tool Co., Chicago, announces new bulletin on mechanics length high speed drills (15% shorter than jobbers length) in fractional sizes from 1/16 to ½ in and in wire gage sizes from 1 to 80. Company also announces booklet on principles employed in sharpening twist drills.

Cylinder Firm House Organ 42

Covering field of air and hydraulic cylinder manufacturing, and including die cushions, boosters, counterbalance cylinders, and dust pressure pumps new external house organ, "Hyd Air", is announced by **Miller Motor Co.**, Chicago

Small Gears 43

Describing different types and applications of small gears from 12 to 96 D.P., new catalog has been published by **Gear Specialties**, Chicago.

Pickling and Washing Machine 44

Developed for preparing surface of metal for application of enamel or other coatings, new spray type machine for continuous pickling and washing of metal parts is announced by **B F Goodrich Co.**, Akron, Ohio

Milling Machine 45

Sundstrand Machine Tool Co., Rockford, Ill, has designed new small duplex type miller to machine two surfaces at same time on opposite ends of work piece such as lock, key, and various instrument parts

Aluminum Melting Furnace 46

Designed for the moderate production needs new gas or oil fired aluminum melting furnace made in single unit of 50 lb capacity or double unit of 100 lb capacity is announced by **Kindt Collins Co.**, Cleveland, Ohio

Material Tester 47

Using a cathode ray tube as an indicator, new instrument, "Ferrograph", for comparing ferrous materials both as to chemical analysis and heat treatment, is announced by **Allen B Du Mont Laboratories**, Passaic, N J

Elevating Table 48

Suitable in handling dies, jigs, and fixtures from press to storage rack, and other similar operations, portable elevating table with a range from 20 to 60 in. is announced by **Lyon-Raymond Corp.**, Greene, N. Y.

ELECTRICAL

Temperature Control 49

Designed for regulation of temperature for tempering, drawing, Al and Mg treatment, sintering metallic baths, and plastic molding, new temperature control instrument, stated to hold tolerances as close as 1/6 deg and off-and-on cycles as short as 8 sec is described in folder from **Claude S. Gordon Co**., Chicago

Terminal Block 50

Suitable for aircraft applications for radio use and other low ampere circuits, new terminal disconnect device designated as YS-1F-1H and covered in Bulletin No YS-1 from **Cannon Electric Development Co.**, Los Angeles, accommodates No 16 AWG wire for 8 amp circuits

Snap Action Switch 51

Data Sheet No 55 issued by **Micro Switch, Div. of First Industrial Corp.**, Freeport, Ill, gives data on Model BZE-2RQ4 snap action switch designed for manually fed presses to reduce fatigue and to protect operator

Vibration Measurement 52

Bulletin No 83 published by **Televiso Products Co**., Chicago contains specifications on Model 11-B vibrometer, for measuring vibrations of moving surfaces

Electric Control Devices 53

Containing descriptions and technical data Bulletin No 100 900 from **Ward Leonard Electric Co**, Mt Vernon N. Y., covers electric control instruments including a c and d c motor starters, speed and voltage regulators, resistors ring and plate rheostats, switches, magnetic contactors, relays, etc

Thermostats 54

Information is available from **Cam-Stat, Inc**, Los Angeles covering new thermostat Model CD100A suitable for use in airplanes Unit has current carrying capacity of 1,500v-amp, ⅛ hp., and 125v-amp pilot duty at 120 through 240v a c.

Rotating Electrical Equipment 55

Catalog No. 46-1 published by **Electric Specialty Co**, Stamford, Conn., covers line of rotating electrical equipment, including dynamotors converters, motor-generator sets, and gas and Diesel electric generating plants

Gaging Instrument 56

Known as "Measuray" and utilizing X-ray and electronic methods new gaging instrument is introduced by **Sheffield Corp**, Dayton, Ohio for continuous or spot checking of thickness of moving material

Selenium Rectifier 57

Weighing 4½ lb., new selenium rectifier being produced by **Federal Telephone & Radio Corp.**, Newark, N J., is known as FTR 1347 AS It's stated to charge any 6v lead acid battery at 6-8 amp., from any 115v., 60 cycle, a c outlet.

MANAGEMENT & EMPLOYEES

Machine Progress Presentation 58

Including a 19 x 25 in wall chart and booklet by Leighton A Wilkie titled "Your Life in the Machine World", new presentation for distribution to industrial management and workers has been published by **DoAll Co**., Des Plaines, Ill. to give history and basic understanding of causes and problems of machine age

STEELS

Alloy Steels 59

Description physical properties, and size data covering No. 6-317 and No 158 chrome nickel alloy steels are given in booklet published by **Carpenter Steel Co.**, Reading Pa

Stainless Steels 60

"A Guide for the Selection of Seamless and Redrawn Welded Stainless Steel Tubing" is new publication from **Summerill Tubing Co.**, Bridgeport, Pa Contained is information on characteristics and applications, analyses, and mechanical and physical properties of seven types of stainless steel tubings.

PLANT SERVICES

Scale Models 61

"Losing Your Grip Over a Gripe?" is folder issued by **Medatform**, Colorado Springs, Col., describing use of company's special scale models, which may be employed in planning and laying out airports, hangars, and administration buildings.

AIRCRAFT & ACCESSORIES

Test Equipment 62

Hydraulic Machinery, Inc., Dearborn, Mich, has issued brochure on aircraft test equipment for checking hydraulic devices, with capacities up to 30,000 psi before and after assembly into aircraft

Wheel Bearing Greases 63

Including charts and diagrams bulletin from **The Texas Co.**, New York City, provides maintenance personnel with information on wheel bearing greases and their proper application

AIRPORTS

Earth Moving Equipment 64

Caterpillar Tractor Co., Peoria, Ill, has issued two new catalogs on firm's earth moving equipment suitable for use in building airports.

★ COMING UP ★

Dec. 2-4: SAE National Air Transport Engineering meeting, Edgewater Beach Hotel, Chicago.
Dec. 3: Air Transport Assn Board of Directors meeting, Washington, D. C.
Dec. 4-5: Air Transport Assn. annual membership meeting, Washington, D. C.
Dec. 9-11: Annual meeting Society for Experimental Stress Analysis, New Yorker Hotel, N. Y. C.
Dec. 10: IATA North Atlantic Traffic Conference, N. Y.
Dec. 12-15: International Aviation Celebration, El Paso, Tex., auspices Chamber of Commerce.
Dec. 16-18: Aviation Distributors & Manufacturers Assn fourth annual meeting, Edgewater Beach Hotel, Chicago.
Dec. 17: Tenth Wright Brothers Lecture, Washington, D C.
Dec. 17: Anniversary dinner, Aero Club, Statler Hotel, Washington, D C
Jan. 6-15,'47: Aviation of Tomorrow Exhibit, Miami
Jan. 10-12: All American Air Maneuvers, Miami, Fla.
Jan. 11-19: Aviation of Tomorrow Exhibit, Miami, Fla
Jan. 28-30: Fifteenth annual meeting, IAS, N. Y. C.
Feb. 1-8: New York Aviation Show, Grand Central Palace
Feb. 1-28: Inter-American lightplane cavalcade, Brownsville, Panama
March, '47: IAS Aircraft Propulsion Meeting, Cleveland, Ohio
Apr. 18-27: Michigan Aviation Week, sponsored by Aero Club of Mich., Detroit.
May 9-17: Air Fair, sponsored by Aviation Council of Metropolitan St Louis.

The high degree of precision and dependability of all CRECO crystal units has been proven by the many "Repeat orders" we have received from all communications fields.

The expansion of our crystal manufacturing facilities enables us to supply the ever increasing demand for high quality units. We are in position to make rapid delivery, not only of our standard units, but also special types custom made to fit your specific requirements.

We welcome inquiries for crystals in any quantity, size or frequency and invite requests for assistance in solving your crystal problems.

— Write today for your free catalog —

COMMERCIAL RADIO EQUIPMENT CO.

HOLLYWOOD | 603 PORTER BUILDING KANSAS CITY 2, MO. | WASHINGTON, D. C.

Radio Consulting Engineers | *Frequency Measuring*

ACCURACY

"Where Accuracy Counts We Win"

- larger profits
- lower sales costs
- better customers

Practically every new Globe "Swift" will be equipped with an Aeromatic Propeller. Aeromatics are also used on most North American "Navions," Johnson "Rockets" and Bellanca "Cruisairs." The Aeromaster, an adjustable pitch propeller is standard equipment on Republic "Seabees."

. . . they're all yours when you sell

AEROMATIC PROPELLERS!

If you wrote your own ticket . . . you couldn't ask for more profitable features than those of Aeromatic Automatic Variable Pitch Propellers. Aeromatics bring a sizable profit on the initial sale. Aeromatics are easier to demonstrate, easier to sell, with lower sales costs. Aeromatic owners get more fun out of flying . . . become better prospects for your other goods and services. Aeromatics benefit from "word-of-mouth" publicity by enthusiastic owners. And they're an exclusive item, too!

The Aeromatic is the *only* fully automatic variable pitch propeller. It varies its own pitch in response to natural forces . . . utilizes full engine power at rated speed . . . insures maximum performance under all flight conditions . . . without any extra controls or gadgets. Result: Aeromatic-equipped planes take-off with up to 33% shorter runs . . . climb up to 25% faster . . . get top cruising performance on minimum fuel consumption . . . make long, flat glides for safe landings with a quick pick-up if the pilot overshoots his field.

Why not send this page to your manufacturer or distributor today . . . along with a note asking whether Aeromatic Propellers can be made available for the planes you sell. He's interested in proven methods for boosting the popularity and sales of his planes. And the profitable Aeromatic business you can build makes it worthwhile! Aeromatic, 642 Scott Street, Baltimore 3, Maryland.

Send this page to your distributor or manufacturer after reading

SELL THE ONLY FULLY AUTOMATIC VARIABLE PITCH PROPELLER FOR . . . *shorter take-offs, faster climbing, better cruising, safer landings.*

THE PROPELLER WITH A BRAIN FOR EVERYMAN'S PLANE

Air-controlled automatic propeller

Aeromatic

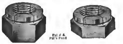
Licensed under patents of EVEREL Propeller Corp.

KOPPERS COMPANY, INC., BARTLETT HAYWARD DIVISION

There's Security in the Air

In tha Aviation industry thara is one all-important factor—*safe speed in the air*. To be *sure* of this, manufacturers of aircraft must be *sure* of the products they use.

Because "Unbrako" Screws are extraordinarily strong—accurate and dependable—they are the choice of those manufacturers whose powerful planes carry precious cargos day and night—through good weather and bad.



Pat'd & Pat's Pend

FLEXLOC

FLEXLOC self-locking nuts are of one piece all-metal construction. Every thread, including the locking threads, takes its share of the load and therefore "Flexloc" Thin Self-Lockers are especially advantageous. They are practically unaffected by temperatures up to 650° F—and can be used over and over again without losing their ability to lock. Sizes from #6 to 1" in diameter. Millions upon millions in use.

This "Unbrako" Socket Head Cap Screw has a Knurled head, which makes it slip and fumble-proof—it can be screwed in faster and farther, even with oily fingers before a wrench must be used. Its superior strength and internal wrenching feature facilitates compact construction.

The Internal Wrenching Bolt and 100° Flush Head Socket Screw meet the extreme degree of precision, tensile, fatigue and inspection demanded by the aircraft industry. Their close tolerances are possible because of our skilled craftsmen and modern precision equipment.

You can't screw Socket Screws in or out without a hex socket wrench,—so why not get our #25 or #50 "Hallowell" Hollow Handle Key Kit which contains most all hex bits.

Kits Pat. Pend

UNBRAKO

Reg. U. S. Pat. Off.

Knurling of Socket Screws originated with "Unbrako" in 1934.

"Unbrako" and "Hallowell" products are sold entirely through distributors.

OVER 43 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA., BOX 566 • BRANCHES: BOSTON • CHICAGO • DETROIT • INDIANAPOLIS • ST. LOUIS • SAN FRANCISCO

NEW DESIGN for SAFER flying

THE Irvin *Chair* Chute is a new conception in parachute protection for cabin planes . . . a chute that combines beauty, convenience and comfort with tested safety. Now you can enjoy all the advantages of a chute without the necessity of "wearing" a chute . . . or of "remembering" it . . . or carrying it about . . . or finding a place to store it. For the Irvin *Chair* Chute becomes a part of your plane . . . is fitted into the back of every seat. Merely step into your plane and parachute protection is yours.

More and more private plane owners and companies using planes for business travel are installing Irvin *Chair* Chutes . . . for added protection in flight. Write today for descriptive circular and particulars about Irvin *Chair* Chutes for the plane you own or plan to buy.

1 This is the Irvin *Chair* Chute . . . fitted into the back of the seat . . . upholstered to match the rest of the chair.

2 The rip cord handle is big . . . convenient. The chute itself is a comfortable back rest . . . does not take up extra space.

3 The harness is tucked into the side of the chair . . . out of the way but instantly available. You can put it on in a jiffy while seated.

4 Lower part of the harness is set in this handy pocket. When you stand up, with the harness on, the chute lifts out of the chair.

FEEL SAFER... BE SAFER... with the new Irvin Chair Chute

Irvin *Chair* Chutes installed in Beechcraft and Ercoupe planes. Normally you fly without the harness . . . comfortably . . . safely. In an emergency, the harness is buckled on in a jiffy and you are ready for any eventuality. *Chair* Chutes cost little . . . are easily installed.

IRVIN Air Chute — The Life Preserver of the Air

IRVING AIR CHUTE CO., INC.

1670 JEFFERSON AVENUE, BUFFALO 8, NEW YORK

S E R V I N G   T H R O U G H   S C I E N C E

It "Gives"

only where you touch it!

Did you ever plunk down on a sofa next to someone... only to find him "falling" toward you, off balance?

That happens when the whole "innards" of a sofa sag between different weights. But it's something that can't happen with Koylon Foam!

As you can see from the pictures, Koylon Foam provides *independent suspension*..."gives" only where you touch it. You can credit Koylon's amazing air-buoyancy for this.

Actually Koylon is 85% air. It "breathes"... absorbs air in millions of tiny, interconnecting cells of resilient latex—releases it on contact with the body.

Here's foolproof evidence of the resilience that gives Koylon Foam its *matchless comfort*. And it's another reason why we say: If you sell "seats"—or "sleep"—better sell Koylon Foam!

"U.S." Koylon FOAM

Comfort Engineered for Sitting and Sleeping

"U. S." KOYLON FOAM DIVISION · MISHAWAKA, INDIANA

UNITED STATES RUBBER COMPANY

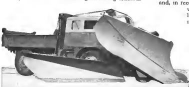
HOW MUCH DOES A BLIZZARD COST?

THE COST of a blizzard to your airport is *not* merely the outlay for snow clearance. The real cost is measured in how long your airport is out of action—in lost income due to cancelled flights—in accidents due to hazardous runway conditions. The longer the tieup, the greater the loss.

Against this toll, the investment for the most modern, powerful, specialized snow removal equipment is low indeed. Ask any airport protected by Walter Snow Fighters! They'll tell you that Walter Snow Fighters bring blizzards under control faster than any equipment—remove a greater volume of snow—do a cleaner, more thorough job.

As a result, you save all around. Fewer Walter Snow Fighters are required to do a better, faster job. Your snow clearance expenditure per storm is lower. Your runways are kept usable for emergency landings during the storm—ready for flight resumption when visibility clears.

For over 25 years, Walter Snow Fighters have been outstanding in highway snow clearance and, in recent years, equally effective in runway clearance. Write us for detailed literature and latest information on modern airport snow clearance.



WALTER MOTOR TRUCK CO. 1001 19 Irving Ave. Ridgewood 27, Queens, L. I., N. Y.

WALTER SNOW FIGHTERS

SOFT
TOUGH
DUCTILE

Globeiron

SEAMLESS TUBING

INDUSTRY asked for a seamless tubing with high magnetic permeability, uniform ductility, softness, toughness, and corrosion resistant properties. We supplied it in Globeiron Seamless Tubing. Because of its right combination of all these properties, Globeiron is extensively used in the electrical and radio industries; housings for generators and motors are frequently fabricated from Globeiron. It is extensively used for many pressure tubing applications It can be worked hot or cold.

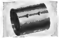
Some of your tubing problems may be profitably solved through the use of Globeiron Seamless Tubing. Globe engineers, Globe laboratory facilities are at your service. Write for Bulletins 109A and 113.

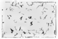
Globeiron is a high purity, low carbon iron, often known as "ingot iron". The physical properties of Globeiron make it ideal for difficult forming operations.

High Magnetic Permeability

(Generator Housing)

Housing for generators and motors may be thinner and lighter when made of Globeiron. The shell of the Dynamotor shown here is an example of Globeiron adaptability.





Under the microscope (mag. 200x Nital Etch) Globeiron shows a uniform structure of almost pure ferrite with only occasional patches of pearlite.

GLOBE STEEL TUBES CO.
MILWAUKEE 4, WIS., U. S. A.

GLOBE TUBES

5028

★ PRESSURE TUBES ★ MECHANICAL TUBING

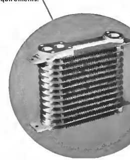
★ CONDENSER & HEAT EXCHANGER TUBES ★ GLOBEIRON HIGH PURITY IRON SEAMLESS TUBES ★ GLOWELD WELDED STAINLESS STEEL TUBES ★ SEAMLESS STAINLESS STEEL TUBES

America "takes to the air" in modern, dependable planes—and an essential factor in their dependability is oil temperature control.

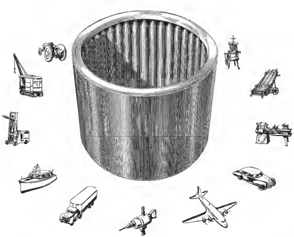
Harrison coolers, by maintaining oil temperatures within the required range, safeguard engine performance and prolong engine life.

Backed by unexcelled testing facilities, Harrison engineers are at your service for the study of your specific requirements.

HARRISON
OIL COOLERS



HARRISON RADIATOR DIVISION
GENERAL MOTORS CORPORATION • LOCKPORT, NEW YORK



It has an ever widening circle of application

In virtually every type of mechanical equipment, Torrington Needle Bearings are serving in an increasingly varied range of applications . . . whatever the load and speed requirements.

The reason lies both in their tremendous radial capacity—greater in relation to O.D. than in any comparable bearing—and in their low coefficient of starting and running friction—with no practical speed limitation on their application. Behind these advantages lies the principle of Needle Bearing design—a full complement of small diameter precision rollers which provide maximum area of bearing contact surface.

Then too, many other important Needle Bearing features—compact size, unit construction for easy installation, efficiency of lubrication and low initial cost—widen the scope of their application to modern machines.

As a designer, manufacturer or operator of mechanical equipment, you should know about these and other Torrington Needle Bearing advantages. Write today for our Catalog #32, or consult our Engineering Staff on any specific friction problem.

THE TORRINGTON COMPANY
TORRINGTON, CONN. SOUTH BEND 21, IND.
Offices in All Principal Cities

TORRINGTON NEEDLE BEARINGS

You save *2 ways* when your drums are equipped with Tri-Sure Closures

1

You save when your drums are in *transit*

The Tri Sure Closure has a seal, plug and flange that are precision-interlocked — absolutely air-tight, leak-age-proof and pilferage proof — the most reliable device ever developed for the protection of liquids in drums. You prevent possible loss or spoilage — and save valuable gallonage — whenever a shipment is made in drums equipped with Tri Sure Closures

2

You save when your drums are *emptied*

The flange of the Tri-Sure Closure fits perfectly *flush* with the inside of the drumhead. This flush fitting of the flange assures *complete drainage* of the drum's contents — and the saving of gallonage which otherwise would be wasted. Your saving averages over 8 ounces per drum — amounting to more than 650 gallons in a shipment of 10,000 55-gallon drums.

Tri-Sure
CLOSURES

AMERICAN FLANGE & MANUFACTURING CO. INC., 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.
TRI-SURE PRODUCTS LIMITED, ST. CATHARINES, ONTARIO, CANADA

Designing aircraft for higher crew efficiency and passenger comfort

The first complete reference on the vital problems of the human element in aircraft design . . .

This book supplies the most complete compilation and interpretation of biological data yet offered the design engineer and airlines executive to enable them to improve the efficiency of air crews, and the safety and comfort of air travelers. It provides the means for practical application of all this data—emphasizing the integration of mechanical advancements with *the abilities and limitations of the airman and passenger*. It points up how such elements as altitude vision heat and cold, vibration, ventilation, noise, carbon monoxide, motion, etc., affect the human being, and arranges them for the practical application of the design engineer.

Just published!

HUMAN FACTORS IN AIR TRANSPORT DESIGN

By Ross A. McFarland

Division of Research, Graduate School of Business Administration, Harvard University

670 *pages*, 6 x 9, 82 *tables*, 144 *figures*, $6.00

This book is the result of extensive study on the actual affect of all the elements of aircraft operation and travel on the human being. It reflects the combined experiences of the major aircraft manufacturers and airlines—applies the most modern biological data directly to aeronautical design, to achieve a definite picture of the precise limitations of the human being regarding air travel. It emphasizes the aspects of design which will increase the comfort and safety of the air passenger.

The book includes important, up-to-date information, such as:

- —recent advances in all aspects of human biology applicable to air transport design
- —studies carried on during the war not readily accessible in scientific literature
- —illustrations of defects in present planes and their human applications
- —specific recommendations covering design provisions for human variables
- —much hitherto unpublished engineering and scientific material

Read over these 13 chapter headings:

1. Introduction
2. The Trends and Characteristics of Air Transportation
3. High - Altitude Operations and Pressurized Cabins
4. The Control of Ventilation, Temperature and Humidity
5. The Control of Insects and Air-borne Diseases
6. Carbon Monoxide and Other Noxious Gases
7. The Control of Noise in the Cabins of Aircraft
8. The Control of Vibration in Air Transport Planes
9. Acceleration Motion and Flight Performance
10. The Cockpit and Control Cabin of Air Transports
11. Passenger Accommodations of Transport Planes
12. The Prevention of Aircraft Accidents
13. Conclusions

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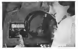
MY **AIRADIO** GIVES ME **MORE POWER PER RADIO OUNCE** THAN ANY SET I'VE HEARD!

No Other Two-Way Radio So Amazingly Easy to Operate!

New Airadio "Super 52" Operates Entirely from Instrument Panel! Convenient as Your Throttle! Automatic Volume Control Prevents Overloading!

POSTCARD SIZE FOR HANDY INSTALLATION. Fits any average instrument panel. Total weight (receiver, transmitter, power supply) 10 lbs. 10 ozs.



SIMPLIFIED DESIGN FOR RAPID TUNING. Just three knobs and switch for band selection. Slide rule dial.

CLEAN-CUT INTERIOR DESIGN FOR MAXIMUM EFFICIENCY. Full-size tubes can be replaced anywhere.

No more reaching, stretching, turning to work the radio on your plane! Everything about the Airadio "Super 52" is designed for your quick convenience in flying.

A flick of the switch takes you from your favorite dance band to the radio range . . . highway of the air! A twist of the dial puts you in immediate touch with the control tower! Another flick—and you're speaking on the interphone to your passengers.

But convenience is just *one* reason why the Airadio "Super 52" is your best buy. The Airadio two way system offers you such other superior features as these:

- *Built-in range filter that insures clear reception of voice signals over range tone signals.*
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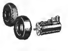

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Of Aviation, published monthly at Albany, N. Y., for October 1, 1946.
State of New York }
County of New York } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared J. A. Gerardi, who, having been duly sworn according to law, deposes and says that he is the Secretary of the McGraw-Hill Publishing Company, the publishers of Aviation, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit:

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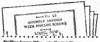

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